



Music on Our Minds: **The Rich Potential of Music to Promote** **Brain Health and Mental Well-Being**

Global Council on
Brain HealthSM
A COLLABORATIVE FROM AARP

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Background: About GCBH and Its Work

The Global Council on Brain Health (GCBH) is an independent collaborative of scientists, health professionals, scholars, and policy experts from around the world who are working in areas of brain health related to human cognition. The GCBH focuses on brain health relating to people's ability to think and reason as they age, including aspects of memory, perception and judgment. AARP convened the GCBH to offer the best possible advice about what older adults can do to maintain and improve their brain health. GCBH members gather to discuss specific lifestyle issue areas that may affect people's brain health as they age, with the goal of providing evidence-based recommendations for people to consider incorporating into their lives.

Many people across the globe are interested in learning that it is possible to influence their own brain health and in finding out what can be done to stay as sharp as possible as they age. We aim to be a trustworthy source of information, basing recommendations on current evidence supplemented by a consensus of experts from a broad array of disciplines and perspectives.

Knowledge about brain health is expanding rapidly. GCBH's work empowers individuals to benefit from insights on the cutting edge of science and enhance well-being through the course of their lives.

Brain Health and Music

The GCBH convened a group of experts in Washington, DC in February 2020 to examine the impact of music on the brain. Throughout the sessions, experts examined evidence on whether and how music influences brain health, looking for areas of agreement and identifying areas that require further exploration. Participants are listed in Appendix 1.

Our discussions led to a series of recommendations and consensus statements intended to help people understand the potential that music holds for supporting and enriching brain health. This paper summarizes those findings, while identifying gaps in the evidence base that researchers need to pursue. It also provides a glossary of technical terms used in the document, and lists resources for readers who wish to learn more.

The GCBH focuses on useful information for men and women age 50-plus, adults in different stages of health, and

caregivers. Where possible, this report touches on cognitive outcomes in older adults. However, music's effects on the brain start in infancy, and much of our discussion applies to people of all ages. This report is not intended to be a systematic, exhaustive review of all pertinent scientific literature on the topic. Rather, it highlights major issues in the field, with an awareness of the public's need for reliable information on brain health. Selected references at the end of the document provide helpful background material and present a sizeable sample of the current evidence underpinning the GCBH consensus in this area.

The recommendations are based on the best available evidence to date, coming from observational studies and randomized controlled trials, as well as reviews of the literature published in peer-reviewed journals. Details and issues that led to GCBH's recommendations are laid out in the discussion sections of this report. The process used to develop this report is described in Appendix 2.

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INTRODUCTION

Music is enjoyed by people of all ages around the world. Song and rhythm are a universal language that bridges cultures and dates back to ancient times. A vulture-bone flute found inside a cave in Europe is thought to be over 40,000 years old. Greek philosophers mused about the healing effects of music on the body and soul.

You don't need to be a scientist to know that music can engage us physically and emotionally. The right song might prompt you to tap your toes or snap your fingers. It might inspire you to hum or sing or get up and dance. Music can spark memories from many years in the past – bringing back sights, smells and feelings from when we first heard the song that is now blasting through a wireless speaker.

For many people, music is a great pleasure that brings well-being and happiness. It can encourage a sense of calm and fight depression. It can stimulate social bonding. Music training in childhood imparts benefits that may endure throughout life.

These remarkable properties arise from music's capacity to engage many different areas of the brain in a coordinated fashion in real time. Science has shown that music stimulates different areas of the brain, which influence how we experience music in our thoughts and feelings. Researchers have also developed evidence that music enables different parts of the brain to operate in sync, bringing further dimensions to the experience.

Health science research suggests that music can enhance a sense of well-being, reduce stress, facilitate interpersonal connections, modulate the cardiovascular system, improve balance, and boost the immune system. And from a risk-

benefit perspective, music can help achieve these health benefits without any of the adverse effects that are sometimes associated with drug treatment. So in addition to providing fun and pleasure, music has the advantage of being a safe and inexpensive health booster.

Intriguingly, research shows that memories of music are durable over years and can often remain intact, even in cases of dementia in advanced Alzheimer's Disease when other memories are beyond reach. Because of this and the other reasons listed above, music-based treatments are being used in therapy for dementia, where it has been shown to help reduce stress, promote morale and encourage interpersonal connections. This report will document inspiring examples of this approach, such as singing in a group with others. Music making is also being used in motor therapies for people who experience a stroke, where it has helped people regain speech and control over their movements.

These uses of music can help transform people's lives, yet many questions remain. This report reviews the current state of the evidence supporting the utility of music-related activities in maintaining and improving brain function in healthy aging and age-related brain diseases. Researchers need to learn more about the relationship between music and cognition – our ability to think, learn and remember. While GCBH experts agree that a lot more research needs to be done to close the gaps in our knowledge, they also agree that music-related activities have many benefits and show significant potential to support brain health as people age. Building on this knowledge, while learning how to apply more of music's potential to help the brain, holds the promise of improving people's lives.

CONSENSUS STATEMENTS

These consensus statements and recommendations that follow are based on extensive sources and research underlying the basic science of the impact of music listening and music making and the brain, including randomized controlled trials and observational studies. The results of such studies were published in peer-reviewed journals and included in systematic reviews of the research. Definitions of the terms used in the consensus, recommendations, and practical tips are provided in the discussion sections and attached glossary (Appendix 3).

NOTE: This report is being finalized during the COVID-19 pandemic when people must take the necessary steps to avoid spreading the virus through physical distancing. Group music activities such as choral singing among older adults in person must be postponed for safety until we have the right measures in place to stop transmission of the virus. Therefore, the GCBH advises following public health guidelines and adapting these recommendations for engaging in social musical activities in ways that put physical distance between yourself and other people outside your home.

Music in Healthy Aging

1. Music is a powerful way to stimulate your brain.
2. Music impacts different regions of the brain including those involved in hearing/listening, movement, attention, language, emotion, memory, and thinking skills.
3. Music engages multiple parts of the brain and helps them work together.
4. Music can help people recall meaningful memories and emotions.
5. Music is important to promote mental well-being. See, [Brain Health and Mental Well-Being: GCBH Recommendations Feeling Good and Functioning Well](#).
6. Any style or type of music can be beneficial for the brain. It's important to take into account a person's musical preferences to maximize music's potential to promote mental well-being for that person.
7. Playing music, singing, or dancing together is a good way to increase social connections with other people and reduce loneliness, which is good for brain health. See, [The Brain and Social Connectedness: GCBH Recommendations on Social Engagement and Brain Health](#).
8. Music and dance are closely linked. Music motivates movement. Dance and other forms of physical activity are good for brain health. See, [The Brain-Body Connection: GCBH Recommendations on Physical Activity and Brain Health](#).
9. Learning to sing a new song, learning to play an instrument or learning to dance stimulates people's thinking skills. See, [Engage Your Brain: GCBH Recommendations on Cognitively Stimulating Activities](#).
10. Music allows us to change our emotional state and can often improve mood.
11. Listening to music can help you manage stress.
12. Music can have positive effects on the body and mind, including helping to regulate blood pressure and heart rate.
13. Sleep is important for brain health, and music has been shown to help improve quality and length of sleep. See, [The Brain-Sleep Connection: GCBH Recommendations on Sleep and Brain Health](#).

Music as Treatment for Diseases or Injuries Causing Cognitive Impairment

1. The ability to dance, sing, and listen to music or play a musical instrument can be preserved in people with dementia, even during later stages of the diseases.
2. Music for persons living with dementia can improve mood and quality of life, and can reduce anxiety and depression. There is mixed evidence that music may also reduce agitation. Ongoing therapy with music the person likes is necessary to maintain the benefits.
3. Music provides a way for people with dementia to share positive experiences with others and can be a good way to connect with their caregivers.
4. There is strong evidence that a specialized music-based treatment can improve movement in patients with Parkinson's disease and stroke, including improvements in walking and talking.
5. There is strong evidence that music helps recovery from stroke. Singing has been shown to help recover the loss of language functions in people due to stroke.

RECOMMENDATIONS

Recommendations for Individuals:

1. Incorporate music in your life. Music may improve well-being including quality of life. Listening to music provides a resource for enjoyment and entertainment, especially when shared with families and loved ones.
2. Dance, sing or move to music. These activities not only provide physical exercise but they can also relieve stress, build social connections, and are fun ways to stimulate your brain!
3. Enjoy listening to familiar music that comforts you and evokes positive memories and associations.
4. Try listening to new music. While listening to music that you know and like tends to cause the strongest brain response and dopamine release, unfamiliar melodies may stimulate your brain, while providing a new source of pleasure as you get used to hearing them.
5. Listen to music to encourage yourself to exercise. Music can provide a mental boost and help motivate you to move your body. And it can hasten clearance of lactic acid buildup during recovery from vigorous exercise.
6. Don't delay getting your hearing checked if you notice you are having trouble hearing. Correcting hearing loss as soon as possible is important for maintaining brain health and preserving cognitive function (as well as continuing to enjoy music!).
7. Make music yourself! Music making can include both singing and playing an instrument. Learning to play a musical instrument can offer a sense of mastery and self-esteem, while enhancing brain activity. Singing may be the simplest way to get started.
8. Try making music with other people. Singing or playing music with and for others can generate positive feedback that enhances self-esteem and provides a satisfying sense of accomplishment. It also can create friendly new bonds with your fellow performers. The benefit of making music with others is not limited to performing music; it also can reduce feelings of isolation.
9. Try joining or forming a music-making group, such as a community choir, band or orchestra. Making music in groups creates cohesion and a sense of belonging that can promote your mental well-being.
10. If you are unhappy, try listening to or making music to improve your mood or relieve feelings of depression.

Recommendations for Communities:

1. Support or start a community-based music making group such as a choir. Music-making activities, such as choirs and writing songs as a group, have shown to increase mental well-being for group members.
2. Don't think music making is limited to formal, in-person organizations. Facilitating connections with one or more people through virtual platforms and social media also can be beneficial.

PRACTICAL TIPS

- 1.** Explore technology that can enable you to listen to music across multiple devices such as your phone or television. Try music apps such as Spotify or Pandora which will offer suggestions of new music you might enjoy, based on algorithms identifying similar sounding music to your current selections.
- 2.** If you have tinnitus, try music to help mask the annoying buzzing or ringing you hear. Tinnitus is the perception of constant or periodic noise in the ears that increases in prevalence with age and hearing loss and affects about 15-20 percent of people over age 60.
- 3.** When many other abilities are compromised through frailty or ill-health, try enjoying music as one of the best ways to engage in a pleasurable activity.
- 4.** Consider using music to encourage mindfulness and minimize negative thinking; music is often used as part of cognitive behavioral therapy techniques to help improve mood, anxiety and depression.
- 5.** Caregivers for people living with dementia should try to use music the person likes as a way to help them reduce anxiety, depression and agitation and help connect them with loved ones.
- 6.** Nursing facilities should use evidence-based music therapy, incorporating music that residents enjoy, to reduce symptoms of depression, anxiety and agitation, while decreasing the use of antipsychotic drugs and sedatives. Providing music that people enjoy can induce feelings of nostalgia, happiness and calm without the down-side risks of medications.
- 7.** Implement community music programs that can have beneficial effects for many people, including individuals living with dementia and their caregivers.

DISCUSSION

Our discussions and review of the academic literature, including research from the GCBH issue experts, make clear that music is a powerful force that can improve mental health and well-being. But a great deal of work is needed to better understand how our brains hear and perceive music, and whether music has a role in promoting adults' memory and thinking skills as they age. The science is still developing on some of the most fundamental questions, such as whether listening to or performing music can help protect the brain against cognitive decline. For example, we know that playing a musical instrument requires the use of many different cognitive skills, such as attention and memory, but we don't know whether continually using those parts of the brain actually helps maintain those functions in later age. There is also some evidence that playing an instrument throughout life is associated with a lower risk of dementia, but we don't know whether performing music actually causes the brain to be more resilient to disease. And we don't know whether the evidence that resilience observed in the brains of musicians is only true for people playing since childhood, or whether it applies equally to musicians who begin to play late in life or for those who only listen to music.

People who observe music's powerful effects on mood, emotions and movement for individuals of all ages have high hopes that it can also help improve and maintain attention, reasoning, memories and speed of processing information. But we simply do not have sufficiently strong scientific evidence to conclude definitively that it does. In fact, even when we have fairly good evidence of music's effect on the brain and how it works, we have not yet established that its positive impacts will result in long-term benefits to maintain the brain's ability to maintain cognitive functions such as thinking and reasoning, or how to harness it to obtain maximum therapeutic benefit.

While most of the research evidence we have around the benefits of music for cognition involves active engagement in making music, listening to music has been shown to promote mental well-being. There is clear evidence that listening to music you like can help improve mood and decrease anxiety, for example. Moderate evidence exists on music therapy's ability to influence cortisol levels for stress reduction. Less evidence exists for using music therapy and singing to promote the release of oxytocin, the hormone that promotes feelings of well-being. Nonetheless, music therapists and psychologists often recommend listening to music as a well-accepted, affordable and non-invasive way to help people manage stress and stress-related health issues.

But research studies on these issues show inconsistent findings on the ability of music to reduce cortisol levels or increase oxytocin or calm the sympathetic nerve system activity. Methodological challenges include testing music against active control intervention, confounding factors that are not corrected for, or small sample sizes. Furthermore, the evidence on managing stress and its long-term benefit to maintaining cognitive functions related to aging and preventing decline caused by disease is also a developing area of science. See GCBH's report on [Brain Health and Mental Well-Being: GCBH Recommendations on Feeling Good and Functioning Well](#). We also know that meditation has similar beneficial effects on stress levels, and we don't understand what unique elements of listening to or playing music, as opposed to using mental techniques to calm thought processes, result in the positive impact on brain function.

We are learning more about these fascinating questions all the time, however. And this report helps identify what we know so far promising areas to pursue to help us understand these important issues better.

Results of the 2020 Music and Brain Health Survey of Adults

In conjunction with the GCBH's analysis of existing research and scientific literature on music and brain health, AARP conducted a probability-based, nationally representative survey of 3,185 adults age 18+ asking them about their attitudes and engagement in music-related activities and their self-perceptions of brain health.¹ The 2020 AARP Music and Brain Health Survey showed small but statistically significant impacts of music on self-reported mental well-being, depression, and anxiety scales. This survey does not establish cause and effect, but does help to show that people's engagement with music is associated with people's own perceptions of better brain health. Select findings include:

- Adults who engage in music making and listening are more likely to self-report their overall health, brain health, and cognitive function as excellent or very good.
- Listening to music shows a small, positive effect on mental well-being, depression and anxiety. This includes listening to music in the background, attending musical performances, and focused listening to recorded music.
- Most adults have engaged in some type of music making. This includes singing, dancing, playing a musical instrument, or composing music either alone or with a group, either currently or in the past.
- Early childhood exposure to music is related to musical engagement in adulthood.
- A higher percentage of adults who reported more frequent music exposure in childhood say their quality of life and ability to learn new things is excellent or very good.
- Current engagement in music appears to make up for a lack of early childhood exposure as reflected in higher-than-average mental well-being scores.

Select Key Insights/Implications From the Survey Include:

¹ *The 2020 AARP Music and Brain Health Survey* examined U.S. adults' exposure and participation in music throughout their lives. The research was conducted as an online probability-based survey via Ipsos KnowledgePanel® fielded April 1-14, 2020 with 3,185 adults ages 18+. The data were weighted according to CPS benchmarks including gender, age, race/ethnicity, education, census region, income, home ownership, and metropolitan area. The margin of error is ± 1.86 percentage points. Mehegan, L.L. and Rainville, G.A. (2020). "2020 AARP Music and Brain Health Survey." Available at <http://www.aarp.org/musicandbrainhealth>

- Any type of musical engagement – including singing, dancing, playing an instrument, composing music, and listening to music – appears to hold benefits for adults age 18 and older. A variety of different types of music engagement were associated with adults' positive self-reported brain health. A higher percentage of adults who engage in music self-rate aspects of their cognitive function, brain health, quality of life, and happiness as excellent or very good. Adults who engage in music also report lower average levels of anxiety and depression.
- Music participation is an easily accessible way to engage the brain. The benefits of music participation are not limited to those who perform in a professional capacity. Anyone can add music to their daily lives simply by listening to music during everyday activities or attending a musical performance.
- Early exposure to music has long-term benefits into adulthood. Exposure to music in elementary school is related to engagement in music in adulthood. But even if you didn't have much exposure to music as a youth, it's never too late to benefit from engaging in musical activities. For more on how music from childhood and adolescence can make a deep impression, see *Music from Long-Ago Remains Part of Us*, Appendix 4E.

Again, while this survey does not establish that music causes the positive health impacts reported by participants, it does show that music is a very popular leisure activity that is engaging to many people of all ages with promising potential for brain health benefits. For more information on the data from the Survey, see Appendix 10.

Listening to Music Stimulates Many Parts of the Brain

Our experience of music begins when sound vibrations reach our ear drums and enter the auditory system. What follows is a marvel of brain processing. There is probably not an activity in daily life where more parts of the brain are used in real time, including all four lobes of the cerebral hemispheres and the brain stem. Imagine the potential of harnessing all that sweeping, coordinated neural energy to help people maintain brain health – and treat those whose brains are not working properly.

People often find emotional resonance and meaning in music, which we acquire – like language – through the auditory system in the brain. Manipulation of features pertaining to harmony, melody, rhythm and beat give rise to expectancies where the music is going and help to evoke emotion. Our cultural backgrounds and preferences influence how we respond to these musical features. But the stimulation of the brain is not limited to sound vibrations and the auditory system alone. We move to music and feel ourselves moving, both of which themselves generate emotion and bodily responses like rapid heart rate, rapid breathing and sweat. We see a dancer move to music and take in the lighting and scene design and these visual cues combine with our auditory experience of music to enhance emotion and pleasure. Watching a dance performance, musical theater, film and television all affect the brain, and music contributes to this experience.

Research shows that music stimulates the subcortical regions of the brain, sometimes known as the reptilian brain, which is responsible for generating emotions and controlling bodily functions, including heart rate. Research also shows that much of the reptilian brain, comprising the striatum and brainstem, continues to function during Alzheimer’s Disease.

Music Promotes Connectivity in the Brain

Music that we like has a bigger impact on the brain than music that does not move us. Our gut-level responses to music are reflected in brain imaging, which shows consistent neural responses to music that individuals say has a big effect on them. This applies to music that people have known for a long time and music that is part of their culture. These responses appear universal and have been noted around the world.

The brain is never passive, even in a resting state. The brain’s default network, which includes the medial temporal lobe, medial frontal lobe, and other areas, is active when people hear their favorite music and stops operating when they hear music they dislike. Music promotes the coupling of brain areas, essentially tuning different areas of the brain to work together at the same time. Such coupling of brain areas is important in working memory and in connecting what one

hears to what one does. Music may reinforce the coordination of coupled networks, potentially strengthening an older adult’s working memory and the connection between hearing and doing.

Self-selected music tends to engage more areas of the brain, including the default mode network, which involves the medial temporal lobe, medial prefrontal cortex and other areas. Synchronizing disparate regions of the brain enables them to work together, in effect talking to each other, resulting in a richer experience of music.

The Linking of Music and Movement in the Brain

Control over our movements is vital for our health and safety, and underscores the importance of connectivity in the brain. Motor control, which affects physical movement, enables us to walk, balance, swallow and breathe. Music and rhythm have been integrated into therapies for patients with movement disorders caused by neurodegenerative diseases and stroke.

In Parkinson’s disease, for example, many patients struggle to walk and maintain balance. Physical therapy that combines rhythmic auditory stimulation with gait training increases speed, stride and steadiness, and decreases falls. You may not ordinarily think of speech as movement, but it is a type of vocal motor activity. In patients with speech and language deficits caused by left hemisphere stroke, singing has been developed as a therapy to recruit spared neurons in the right and left hemispheres to help with vocal motor operations. (More on this follows in the section on singing.)

Of course, the benefit of music to movement is not limited to those with impairments. It is widely understood that music and rhythms can encourage physical movement – everything from toe-tapping to inspiring you to move off the couch. One of our recommendations is to listen to music to help you exercise. *The Brain–Body Connection: GCBH Recommendations on Physical Activity and Brain Health* shows how exercise is one of the best-known ways to positively impact your brain health. Music provides a mental boost to help motivate you to move your body. It may be the

synchronization with rhythms in the music and/or the release of reward hormones but music can make exercise seem easier. There has even been a small study showing that music can hasten clearance of lactic acid buildup during recovery from vigorous exercise.

Singing has Benefits Both for Healthy Aging and Stroke Patients

The ability to sing is evident from infancy, and does not depend on formal vocal training. Aphasia is the loss of ability to produce and/or comprehend language, a common and devastating complication of stroke or other brain injury. Clinical observations of patients' ability to sing words that they could no longer speak inspired the use of singing for recovery from aphasia, and the subsequent development of Melodic Intonation Therapy (MIT). Case reports and small case series have documented the effects of intensive MIT and reported therapeutic gains in chronic aphasia. A recent study showed self-implemented daily music listening can aid recovery of memory and attention, and improve mood more than audiobook-listening in early phases after stroke. Taken together, these two music-based interventions offer preliminary evidence that active engagement in music listening and music-making through singing therapy may augment recovery of function after stroke. Similarly, singing has been shown to have benefits in other disorders as well as in normal language acquisition.

Importantly, singing fosters interaction/communication with others, and enhances both bonding and cooperation. Further, studies in both healthy older adults and stroke patients have shown that music-making has a positive effect on cognitive status in healthy aging.

During Covid-19, however, singing in groups may allow for the transmission of the virus through aerosols, and therefore group singing, should be postponed or approached with great caution (see earlier recommendations in the consensus statements). For more on adults engaging in group singing see Appendix 4c describing the Unforgettables, a chorus made up of people living with dementia and their caregivers. Appendix 11 describes the experience of adults singing in the Encore Chorale.

Because there are many similarities between speech and singing in the brain, and singing stimulates and connects many different areas across the brain's network, it may be possible to treat loss of the ability to speak and restore function through singing interventions. The involvement of both hemispheres in singing, and the hemispheric redundancy of vocal-motor functions (meaning a vocal motor representation is present on both sides of the brain) likely explains why singing may be capable of helping to restore speech-motor function after stroke.

Evidence for Music Around the World

To date, much of the evidence about music's impact on the brain has derived from the United States and other Western countries. Research suggests that individuals in all societies respond to music in early childhood and across the age span. More cross-cultural research is needed, however, to give scientists a better grasp of music's impact on cognition and the brain.

What is clear is that all societies engage in music, whether as part of formal rituals or casual pleasure. All cultures have songs, and all have musical instruments. Yet what is considered beautiful or moving in one culture may sound alien to another. How music fits into rituals of life also differs among societies. Elements of music, including rhythm, pitch and melodic values, are expressed in differing styles around the world. Gaining further insights into how music affects us, including how the brain responds to different features, such as pitch, rhythm, tone and tempo, may help different societies use music unique to their own cultures as an ingredient in healthy aging.

Musical preferences are very person-centered and we can't make assumptions based on age, ethnicity or culture what a person's musical preferences necessarily will be. For example, AARP's Music and Brain Health Survey showed us that more than 80% of adults 18+ like music from before their generation, almost half (49%) like music after their generation, but few (9%) like only their own generation's music, while preferred musical genres were highly variable. More information on the musical preferences of different groups of people in the U.S. is provided in Appendix 10.

Music-Based Treatments for the Brain

The capacities to enjoy and engage in music – through listening, singing, dancing or playing an instrument – are extremely durable, even when brain health declines.

Music therapy taps into these capacities to treat a wide array of physical and mental symptoms. Trained therapists create sessions for individuals and groups that are tailored to their needs and which may include listening, performing, improvising, and even composing music. They may ask clients to sing along, improvise melodies or play drums. They may encourage individuals to discuss the memories, thoughts and feelings that the music inspires.

The American Music Therapy Association defines music therapy as “the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program.”

Advocates of music-based therapies say the approach can pay off for dementia patients, as well as their caregivers, by enhancing communication, promoting cooperation, facilitating social interaction and improving spirits. But much remains to be learned, and researchers are continuing to investigate the potential of music as a therapeutic tool. Favorable anecdotal accounts are widespread and systematic reviews of the literature are supportive.

The knowledge base is growing. The United States’ National Institutes of Health (NIH), with help from the National Endowment for the Arts, is awarding \$20 million over five years to support research into music’s benefits for a wide range of medical disorders. Music and memory, music and immune function, and music and gait are among the areas to be explored by these research grants awarded in 2019. These projects arose from the Sound Health Initiative, a partnership between the John F. Kennedy Center for the Performing Arts (including renowned soprano Renée Fleming) and NIH, in association with the Arts Endowment. Similarly, the Arts Endowment is supporting research grants and teams around

the country to explore music’s relationship to neuroscience, health, and well-being. All these investments are very welcome, but more research is needed. People will benefit from more knowledge about music’s potential to ease symptoms of dementia, enhance cognitive skills and improve quality of life.

Dance and Music are One and Hold Promise for Reducing Risk for Dementia

The famous dancer Martha Graham once described dance as “a song of the body.” The view that dance and music are intimately linked is reflected in other cultures that describe the two activities as elements in a single form of expression. The ancient Indo-European language of Sanskrit, for example, uses the same word for music and dance.

Dancing to music entails the coupling of auditory and motor functions. Moving to music requires coordination of multiple brain regions, including the brain’s reward center as well as sensory and motor circuits. This synchronicity across the widely distributed neural network for music and dance not only *feels* good but is good – for the brain.

NEUROLOGIC MUSIC THERAPY

Music-based therapies are often employed for their emotional and social benefits. The advancement of science is now paving the way for specialized treatments, including cognitive training, language rehabilitation and speech therapy, based on carefully targeted applications of music.

These emerging techniques have been made possible by studies of brain imaging and brain-wave recordings that increase our understanding of music and rhythm’s impact on the brain. Michael H. Thaut, a professor at the University of Toronto, is a GCBH expert in the neuroscience of music who has pioneered this specialized field, known as neurologic music therapy.

Thaut and his colleagues have created a growing body of research on how the language of music can be applied to different kinds of treatment for brains with disease or injury. The goal is to make available evidence-based therapies that use aspects of music, such as rhythm and timbre, in exercises designed to modify neuropathways and to improve functioning.

Dance holds promise as a way to reduce risk for dementia. In 2003, the *New England Journal of Medicine* reported on a study finding that dance could reduce the risk of dementia, an achievement that was not equaled by 10 other physical activities in the trial. The researchers at Albert Einstein College of Medicine concluded that the mental and social aspects of dancing worked together to provide this cognitive benefit. It is important to note that the study was not limited to dancing, however. Among all leisure activities studied, the authors reported that “reading, playing board games, playing musical instruments and dancing were associated with a reduced risk of dementia.”

Theoretically, dance should benefit people living with dementia, but several randomized control trials using dance as therapy haven’t shown improvement. We aren’t ready to close the book, however. There is a trial studying the impact of dance for people with dementia underway in Australia with 600 people, focused on falls and with cognition as outcomes. We also need to examine the nature of volunteers who are willing to participate in long-term interventions in dance, because it may be that these participants could represent a biased sample. There is evidence on the benefit of dance for movement disorders and well-established improvements, but more research needs to be done on non-disordered people.

Music Can Help with Dementia

Musical appreciation is typically preserved longer than other skills during the course of dementia. Older people with Alzheimer’s disease can often remember music from their youth. Brain imaging studies have demonstrated that memories of songs activate brain areas that are spared until the late stages of the disease. And evidence has emerged that music-related activities may boost memory a bit in some patients.

At a time when the quality of life is diminishing, music can make a difference. People with dementia who sing or play an instrument can often find happiness and tranquility that otherwise may be missing from their lives. Music can help foster social connectedness for individuals with dementia.

Music therapy reduces anxiety, helps combat depression and may mitigate behavioral problems associated with dementia. See, *Caregiving and Music: An “Unforgettable” Connection*, Appendix 4B.

Music can be a non-pharmacological way to treat dementia agitation, which may take the form of aggressiveness, wandering, restlessness and other undesirable behaviors. People with Alzheimer’s disease can remember music from the distant past, and evidence has emerged that music may boost memory (as measured on the Montreal Cognitive Assessment). One study found that memories of songs stimulate particular areas of the brain that are believed to have some resistance to Alzheimer’s – the caudal anterior cingulate (in the cingulate cortex, which plays a role in varied cognitive functions) and the ventral pre-supplementary motor area (which helps control movement).

We cannot say that music increases cognitive abilities for those with dementia. Some evidence suggests that engagement in music during childhood and adulthood may reduce the risk of dementia, and studies are ongoing. Research is needed to assess the relative merits of singing, dancing and playing an instrument. Some studies of dance and dementia have shown benefits to quality of life (New Zealand) or pointed to improvements in mood and visual recognition and decision-making (in a Zumba class in North Dakota, for example). Other studies related to dancing have shown mixed results, however, and as our knowledge gap section points out, demonstrate the need for additional research to draw definitive conclusions on the impact of dance interventions for dementia. Nonetheless, scholars generally agree that enhancing well-being reduces the risk of dementia – and music and dance can enhance a sense of well-being. [See *Music-Based Treatments for the Brain*.]

Neuroplasticity and Music

Our brains are not static and unchanging. Amazingly, they are able to rewire themselves in response to environmental influences, including sensory input, skilled motor outputs, rewards and changing awareness. And this is true for adults of all ages, as well as children. The brain’s extraordinary

ability to evolve is called plasticity. It makes learning possible, enabling personal growth and changes in behavior. Exercising the brain through activities that require physical actions and mental effort may promote this important feature and support brain health.

Participation in music may be one of those activities, and supportive evidence is growing. Some research has suggested that listening to music yields increased performance on cognitive tests, but only temporarily. There is research showing that active participation in music and music making might be more beneficial than listening alone. Long-term experience with music has been linked to changes in the brain's systems for auditory processing and movement control and the regions that integrate information from sensory systems and motor parts of the brain.

Scientists also have found that children who take music lessons may gain permanent intellectual benefits. Imaging has revealed that even short-term practice on the piano can increase brain activity for inexperienced students. [For more on the benefits of musical training, see *But Music Hits a Stronger Chord in Some Than Others*, Appendix 4E.]

Cognitive Reserve and Music

The brain's plasticity helps people accomplish cognitive tasks that are essential in life, such as remembering, reasoning, making judgments and paying attention. [See above: *Neuroplasticity and Music*.] This capacity creates what is known as a cognitive reserve, an invaluable feature that helps people meet the challenges of disease or injury to the brain. The cognitive reserve provides some resistance to damage – and a degree of resilience if damage occurs, such as with Alzheimer's disease.

Not all cognitive reserves are created equal. People who have exercised and challenged their brains throughout their lives gain an edge. And it turns out that musical training is an effective way to help build the valuable cognitive reserve. Reading music, and applying the auditory and motor tasks required to practice it, are examples of ways that music strengthens this capacity. Studies suggest that people who engage in music making as they age, either as a profession or

a hobby, appear to have better brain health over the course of their lives compared to non-musicians.

Music lessons can help build cognitive reserve during adulthood, and the beneficial process continues late in life. More frequent training seems to result in lower risk of dementia. While there is moderate specific evidence for this impact, it is convincing. All agree that music contributes to a healthy, stimulating environment, and such an environment is conducive to building cognitive reserve.

Music Fosters Social Connections

In a world of ear buds and smartphones, people have never had so many options to listen to music in splendid isolation. Still, something powerful and different emerges when music is shared as a group experience. Whether it's a rock concert, church choir or a family gathered around the piano, music connects us. It activates brain circuits that affect empathy, trust and cooperation. And it affirms a sense of belonging and place within a culture. Music also forges connections between those who are performing it, as they work together to stay in sync.

In one experiment, researchers conducted brain scans on college students, and later asked them to rate how empathetic they were as individuals. The scans revealed that those who ranked themselves most empathetic showed more brain activity, including in the reward center of their brains, when listening to songs that they liked. The researchers concluded that individuals with more empathy had greater appreciation of music, and theorized that people process music in a similar manner to how the brain processes empathy for others.

Music Awakens our Emotions

Melodies may sound angry, solemn or peaceful as a lullaby. An old song may prompt memories that are joyful or sad. Close your eyes, and the right music can transport you to a different place and time in your life.

While music is an auditory stimulus, it affects varied parts of our brain, which influence how we feel when we hear it.

The effects are multi-modal and not limited to sound alone. Music can prompt vivid visual memories, make us feel more sociable, and inspire us to move. Scientists are trying to learn more about the precise neural mechanisms that enable the remarkable link between music and emotion. But they have mapped out some of the answers. They agree that the music-emotion link involves the salience and default mode networks, and regions that influence emotions and creativity.

Imagery of the brain has shown that music activates brain structures that play a significant role in emotion, including the amygdala, hypothalamus, hippocampus, nucleus accumbens, cingulate cortex and orbitofrontal cortex.

One researcher created a neurological map showing that music prompts brain activity in the same regions as memory, including the medial pre-frontal cortex, which is behind the forehead. He made this discovery by scanning the brains of students as they listened to a large number of random songs, including tunes that shifted from the more cheerful “major” key to the more somber “minor” key. Interestingly, the music-memory zone he identified is an area that is more resistant to Alzheimer’s than some other parts of the brain.

Music and Neurochemical Responses

One of the ways scientists learn how music affects our minds is by tracking the neurochemicals it generates when we listen to music or perform it. Music appears to stimulate the brain’s pleasure center, [see, Music and the Science of a Life Well Lived, Appendix 4A] enhance immunity [see, How Music Can Boost Immune Function, Appendix 4D] and regulate neurochemicals that help us cope with stress. Scientists are continuing to learn how to take advantage of these benefits to promote better health.

Making music with others, for example, requires a kind of empathy that is associated with the release of oxytocin, a hormone that prompts a sense of love, affection and well-being. Listening to music also shows favorable chemical effects. Researchers have found that people produced more oxytocin after surgery when they were exposed to relaxing music. Another study found that exposure to relaxing music reduced stress during hip replacement surgery. (The evidence came from measuring levels of cortisol, a hormone that increases with stress; subjects listened to music before and during the procedure in which they were somewhat awake.)

Music also may increase the levels of dopamine, a brain chemical that is involved in the sweet anticipation of feel-good stimuli as candy and money and which may cause opiate release related to the pleasure.

KNOWLEDGE GAPS: WHERE MORE RESEARCH IS NEEDED

The experience of music is a complex phenomenon that takes different forms (listening, performing or creating) and engages varied neural networks. There is a strong body of evidence that music stimulates the brain. The use of music to help maintain or improve brain health is a promising area of research. Important gaps remain in our knowledge, however.

- More randomized well-controlled trials are needed with meaningful outcomes to look for evidence on music's efficacy on cognition.
- We know that music across cultures requires more study. Research on the impact of music on brain health should examine the social determinants of health (gender, ethnicity, literacy, socioeconomic status). Not only do we need to make sure this research is designed to be inclusive of different groups and cultures, but it must explore differences between and among people at greater risk for cognitive decline, including African Americans, Latinos, and women. Such differences must be reported in the data.
- Embedded pragmatic clinical trials of music interventions in health care systems for people with dementia, such as those supported by the NIA IMPACT Collaboratory have the potential to accelerate the translation of evidence-based interventions into clinical practice. See <https://impactcollaboratory.org/>
- We need more foundational mechanism research on how music works in the brain.
- We need to develop better outcome measures (to look at joy or flow) to document – and measure – the experiences of music and its benefits. What does “being high on music” or “in the groove” actually mean?
- The explosion of music technology and cognitive performance presents a new and exciting field of research.
- We would benefit from research of the direct and indirect paths of music's impact on cognition. The effects on well-being are very well established, but not enough research looks at cognitive outcomes or the biomarkers of stress. We need to research the link on music's effect on reasoning skills, and whether effects are only short term vs. long term.
- Can music help cognition of individuals with dementia?
- We need more details on how/why music affects people's moods.
- In order how to understand whether music can reduce risk for cognitive decline, we need more knowledge about music and cognitive reserve.
- There are 100 known neuro transmitters but only measures for 6 of them. Dopamine does a lot of things in the brain, but not everything, and biochemical response to music in the brain should be further developed.
- Dance research – more well-designed randomized control trials and systematic reviews on dance and movement – are needed.
- The outcomes of music therapy for people with Parkinson's disease is that it can help them walk better and move normally. Will this therapy benefit others?

CONCLUSION

Music's role in promoting healthy aging will continue to grow as we gain expertise on how to use it most effectively. We know that music stimulates activity in the brain, improves people's moods and encourages connections between people. It has significant potential to enhance brain health and well-being for individuals of different ages and different levels of health.

Few activities can match the social impact of music, such as when adults sing or perform together. In addition, there is evidence that music promotes resilience in the brains of adults by strengthening the cognitive reserve. Such capacity can foster a person's ability to learn throughout life, paving the way for fulfilling new experiences in their later years. Such evidence should be further explored, as society seeks innovative new ways to promote lifelong learning.

A great deal still must be learned about music's remarkable effects on people's mind and body. Society will benefit as we gain understanding of music's impact on such mental tasks as remembering, reasoning and making judgments. Scientists must continue to explore the mechanisms by which music affects our emotions and behavior. Importantly, how to best apply music as a tool in cognitive therapy remains a matter of debate. Whether music can be applied as a tool to improve thought processes for those with dementia remains an unanswered question.

As the global population ages, these issues will become increasingly relevant to many millions of people. The GCBH will continue to follow developments with great interest and revisit the recommendations as appropriate. Insights and innovations on using music to promote brain health can make life better for adults around the world.

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1. PARTICIPANTS, LIAISONS AND LIST OF ADDITIONAL RESOURCES

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List of Additional Resources from Liaisons

The Academic Press recently published a book under the coordination of Cuddy, Belleville and Moussard, “Music and the Aging Brain” (<https://www.elsevier.com/books/music-and-the-aging-brain/cuddy/978-0-12-817422-7>). GCBH Liaison Hervé Platel and his co-author Mathilde Groussard discuss the “Benefits and limits of musical interventions in pathological aging” in Chapter 12. Their chapter helpfully describes the confusion over the words “music therapy” which can sometimes be mistaken to imply that musical interventions can cure disease. But as we tried to emphasize in this report, in the context of aging and neurodegenerative diseases, using music as a therapy which helps to support well-being and quality of life can be a benefit to brain health, even where we don’t have definitive evidence it ameliorates the disease itself.

In 2019, the World Health Organization published a report on the recognition of the impact of artistic practices (including music) on health. See Fancourt D, Finn S. What is the evidence on the role of the arts in improving health and well-being? A scoping review. Copenhagen: WHO Regional Office for Europe; 2019 (Health Evidence Network (HEN) synthesis report 67). Available at <https://apps.who.int/iris/bitstream/handle/10665/329834/9789289054553-eng.pdf>.

United States’ government funded research related to music and brain health:

- The National Endowment for the Arts (NEA) Endowment, supports the data collection of the frequency of music participation (whether music-making, music attendance, or music-listening) among older adults. As an example, see the **2017 Survey of Public Participation in the Arts**, https://www.arts.gov/sites/default/files/US_Patterns_of_Arts_ParticipationRevised.pdf.
- **Staying Engaged: Health Patterns of Older Americans Who Participate in the Arts** (A National Endowment for the Arts report, based on the Health & Retirement Study’s arts module) https://www.arts.gov/sites/default/files/StayingEngaged_0917.pdf.
- **The NIH, the National Endowment for the Arts, and the National Academies collaborated on The Arts and Aging: Building the Science:** <https://www.arts.gov/sites/default/files/Arts-and-Aging-Building-the-Science.pdf>. The link to papers and presentations that resulted from the National Academies workshop appears here: https://sites.nationalacademies.org/DBASSE/CNSTAT/DBASSE_084433.
- The National Endowment for the Arts also funds dozens of research grants and a series of “NEA Research Labs” around the country. Some of those projects have focused on music and its relationship to the cognitive ability of older adults. One example at Colorado State University examines the benefit of older adults with

cognitive impairment attending live performances with their caregivers. A NEA Research Lab at Rice University (<http://arches.rice.edu/>) is looking at examining the role of music in older adults with mild cognitive impairment, while another at Drexel University (https://drexel.edu/cnhp/research/faculty/KaimalGirija/arcs_lab/) seeks to understand music therapy’s role in pain management.

- The Arts Endowment continues to support research (<https://www.nih.gov/news-events/news-releases/nih-awards-20-million-over-five-years-bring-together-music-therapy-neuroscience>) and programming around music, neuroscience, health and well-being—through the Sound Health partnership with the NIH and the Kennedy Center. Together with these organizations, the NEA is establishing a “Sound Health Network” to coordinate research activities.
- Music therapy research and practice affecting military personnel and veterans is a focus of the “Creative Forces: NEA Military Healing Arts Network,” a partnership between the Arts Endowment and the U.S. Departments of Defense and Veterans Affairs. The initiative uses creative arts therapies to combat trauma in these populations and their families and caregivers. See <https://www.arts.gov/national-initiatives/creative-forces>.

See also Appendix 11 for information about the adults singing in the Encore Chorale.

Material from the University of Edinburgh

Early Findings From Research on Lifetime Musical Experience and Healthy Aging in the Lothian Birth Cohort 1936

The Lothian Birth Cohort 1936 is a United Kingdom (UK) study of healthy aging. Researchers at the University of Edinburgh are evaluating data from 1,091 participants starting at the age of 70 years. As a baseline, most of the participants took the same general cognitive ability test at age 11. Participants then completed a detailed battery of thinking and memory tests every three years from age 70 to 82. They have had multiple brain MRI scans and provided extensive health, demographic, psychological and lifestyle data. At age 82 years, 420 participants also completed a lifetime musical experience questionnaire. Using these data, researchers plan to examine whether experience playing a musical instrument is associated with better cognitive, brain, or psychological health in older age or with less decline in these capacities over time. Results so far have shown that around 40% of the participants played an instrument in the past, though only a small proportion (9%) of them currently play a musical instrument at age 82. Those who experienced greater environmental deprivation in childhood were less likely to report experience playing a musical instrument. The first longitudinal analysis of the data suggests that greater experience playing a musical instrument is associated with slightly healthier lifetime change in general cognitive ability (between ages 11 and 70); this

relationship was not explained by differences in childhood environmental deprivation, years of education, or adult occupational social class. These results are in preparation for

publication; the project will run until April 2022 and is funded by the ESRC (ES/S015604/1), UK. See: <https://gtr.ukri.org/projects?ref=ES%2FS015604%2F1#/tabOverview>

2. PROCESS USED TO PRODUCE THE CONSENSUS AND RECOMMENDATIONS

Issue specialists from around the world, who are leaders in their fields, were selected to participate on the GCBH panel on brain health. These experts have conducted research that has significantly contributed to the body of evidence that examines the impact of music on brain health in older adults. Their diverse areas of expertise represent perspectives from disciplines including behavioral neuroscience, cognitive neuroscience, gerontological nursing, music therapy, neurology, neuroradiology, psychology, psychiatry, and rehabilitation medicine.

Twelve issue specialists were asked to critically examine the state of the science as of February 2020. They discussed findings from observational studies as well as randomized controlled trials. Dr. Suzanne Hanser completed a systemic literature review for AARP in 2019, Music and Rhythmic Movement/Dance With Older Adults. The experts considered the cumulative body of evidence to determine whether it is sufficient to issue recommendations for individuals to maintain and improve brain health. The issue specialists considered 19 different questions as a framework to guide their deliberations. The complete list is available in Appendix 5.

After an in-depth moderated discussion, several follow-up conference calls and an exchange and refinement of drafts, the issue specialists arrived at 13 consensus statements to summarize the known impact of music on brain health in healthy aging, and 5 related to music as treatment for diseases or injuries causing cognitive impairment. Based on their

consensus, they made 10 recommendations for individuals and 2 for communities regarding music in the context of brain health for adults. Further, they agreed on 7 Practical Tips aimed at helping people around the world adopt behaviors to improve their brain health.

Liaisons from civic and non-profit organizations with relevant expertise in brain health provided input and technical feedback during the refinement of the draft recommendations.

Seven Governance Committee members attended the meeting in Washington, DC in February 2020. The entire Governance Committee reviewed and finalized the document during subsequent conference calls and emails April - June 2020. The Governance Committee members issuing the recommendations are independent health professionals representing diverse expertise across four continents in epidemiology, psychology, public health, neurology, psychiatry, geriatrics, cognitive neuroscience, neuropsychology, pharmacology, medical ethics, health policy, and neurodegeneration.

The Governance Committee members applied their expertise to determine whether they concurred with the statements and to evaluate the objectivity and feasibility of the proposed recommendations. The GCBH Governance Committee reviewed this summary document to decide whether it accurately reflected the expert opinions expressed and the current state of science in the field. The Governance Committee approved the document in June 2020.

3. GLOSSARY

The glossary highlights how the GCBH used these terms within the context of their discussions and in this document.

Antipsychotics. Drugs used to treat symptoms of psychosis such as hallucinations, paranoia, and severe anxiety.

Anxiety. Apprehensive uneasiness or nervousness. In severe cases can result in a mood disorder where the person experiences extreme worry or nervousness about people, challenges, or events when there is little or no reason for that level of concern.

Aphasia. The loss of ability to produce and/or comprehend language, a common and devastating complication of stroke or other brain injury.

Attention. The concentration of awareness in a focal and perceptive way.

Auditory. Relating to the process of hearing.

Auditory system. The neurological structures and pathways of sound perception.

Blood pressure. The force of blood pushing against the walls of arteries. A blood pressure number of 120/80 mm Hg is generally considered ideal.

Brain health. A state of having good underlying neural mechanisms to support high functioning mental processes of cognition that support well-being.

Cognitive behavioral therapy techniques. Evidence-based methods to change thoughts, feelings, and behaviors and improve overall life satisfaction and functioning.

Cognitive decline. The Institutes of Medicine (IOM) in 2015 defined a similar term, cognitive aging, as the lifelong process of gradual and ongoing, yet highly variable, change in cognitive functions that occur as people get older. Cognitive decline is a term used by the experts to describe losing cognitive abilities over time as people age, absent a specific disease or condition.

Cognitive impairment. The stage between the expected cognitive decline of normal aging and the more serious decline of dementia. It can involve problems with memory, language, thinking and judgment that are greater than normal age-related changes. (Mayo Clinic)

Cognitive reserve. Individual differences in the resilience or adaptability of cognitive processes, such as memory, reasoning and attention, that together help explain why some people are more susceptible than others to age- or disease-related brain changes.

Confounder. A situation in which the effect or association between an exposure and outcome is distorted by the presence of another variable.

Connected. To experience a sense of belonging and welcome in a group.

Cortisol. A hormone that increases with stress.

Dementia. Dementia isn't a specific disease. Instead, dementia describes a group of symptoms related to memory, thinking and social abilities and affecting them severely enough to interfere with independent daily functioning. Though dementia generally involves memory loss, memory loss has many different causes. Alzheimer's disease is the most common cause of a dementia in older adults, but there are a number of types of dementia. Depending on the cause and type of dementia, some dementia symptoms can be reversed.

Depression. A common but serious mood disorder where one feels severe sadness and dejection.

Dopamine. A brain chemical that causes feelings of anticipation of reward.

Efficacy. The degree to which an intervention accomplishes the desired or projected outcomes.

Empathy. Empathy involves an understanding of another person's world by listening to allow a better understanding of the other person's situation, and by responding with verbal and non-verbal messages that communicate affective understanding of that person's situation. Cognitive empathy refers to the ability to recognize and interpret the other person's situation while affective empathy refers to an accurate emotional expression of that person's situation.

Gait. A person's pattern of walking.

Happiness. A range of positive emotions, including joy, pride, contentment, and gratitude.

Heart rate. Also known as pulse, heart rate is the number of times a person's heart beats per minute. A normal resting heart rate for adults is generally between 60 to 100 beats per minute.

Intervention. Any measure whose purpose is to improve health or alter the course of disease.

Language. A formal system of communication which involves the combination of words and/or symbols, whether written or spoken, as well as some rules that govern them.

Meaning. There are three components in personal meaning: (1) cognitive component, which is about making sense of one's experiences in life, (2) motivational component that is about pursuit and attainment of worthwhile goals, and (3) affective component that is about feelings of satisfaction, fulfillment, and happiness accompanying goal and attainment.

Mental. Relating to the mind, including reasoning, thinking, mood, attention, feelings, emotion and interest in activities.

Mental health. A state of mind characterized by emotional well-being, good behavioral adjustment, relative freedom from anxiety and disabling symptoms, and a capacity to establish constructive relationships and cope with the ordinary demands and stresses of life. (APA Dictionary of Psychology)

Mental well-being. People's experiences of feeling good, functioning well and coping adequately with life circumstances and challenges.

Motor skills. Movements and actions of the muscles.

Music. An art form and cultural activity, whose medium is sound, with common elements including rhythm, pitch and melodic values. Music is performed with a vast range of instruments and vocal techniques and expressed in differing styles around the world.

Music therapy. Treatment of physical and mental conditions for individuals and groups that are tailored to their needs and which may include listening, performing, improvising, and even composing music.

Musical engagement. The capacity to enjoy and participate in music activities through listening, singing, dancing or playing an instrument.

Network. The series of neuron connections which control a person's abilities and responses.

Non-pharmacological. Referring to therapy that does not involve drugs.

Observational studies. In observational research, scientists observe groups of people to identify characteristics, such as traits and choices, that are associated with disease or health.

Oxytocin. A hormone that prompts a sense of love, affection and well-being.

Plasticity. The ability to change and adapt, especially the ability of the central nervous system to acquire alternative pathways for sensory or motor skills. (The American Heritage Medical Dictionary)

Randomized controlled trial (RCT). In a typical randomized controlled trial, people are randomly selected to receive either the intervention or a control condition. In a double-blind trial, both the participants and the researchers are unaware of (or "blinded" to) which person received the intervention until after the results are analyzed.

Rhythm. A strong, regular, repeated pattern of movement or sound.

Risk. Risk is the chance or probability of a particular event happening in a group of people with similar characteristics or traits, compared with those not having that characteristic or trait. Making up an individual's overall risk of having a condition is the cumulative effects of factors that increase the chance of developing the condition (risk factors) as well as factors that decrease the chance of developing the same condition (protective factors).

Risk reduction. Reducing risks for cognitive decline or impairment in the abilities to think, reason, and remember

means lowering your chances of experiencing loss in those abilities. A person's overall risk may also be reduced by increasing factors that protect against cognitive decline or dementia. Dementia (due to Alzheimer's disease or another related disorder) is one condition, and cognitive decline (the slowing of thinking and memory in the absence of a major brain disease) is another condition. When scientists study risk reduction strategies for cognitive decline, they are looking for factors that can reduce the risk of impairment to cognitive functions in the population in general. Therefore, some activity or intervention that reduces risk for a particular condition or disease means that a smaller proportion of people who engage in that activity are likely to have the condition or disease. However, risk reduction strategies are not the same as preventing any one individual from getting the condition or suffering from disease. For example, research has long shown that wearing a seatbelt reduces – but does not eliminate – the chance of injuries among people who are involved in automobile accidents, and we nevertheless now recommend people wear seatbelts while they are driving.

Social Cohesion. The perceived degree of connection among neighbors, and people's willingness to intervene for the common good.

Stress. The physiological or psychological response to internal or external stressors. Stress involves changes affecting nearly every system of the body, influencing how people feel and behave. For example, it may be manifested by palpitations, sweating, dry mouth, shortness of breath, fidgeting, accelerated speech, augmentation of negative emotions (if already being experienced), and longer duration of stress fatigue. (APA Dictionary of Psychology) Well-being. Self-evaluation of life satisfaction often described as the state of being comfortable, healthy, or happy.

Stroke. A stroke occurs when a blood vessel that carries oxygen and nutrients to the brain is either blocked or ruptured.

Tinnitus. The perception of constant or periodic noise in the ears that increases in prevalence with age and hearing loss and affects about 15-20 percent of people over age 60.

Well-being. Self-evaluation of life satisfaction often described as the state of being comfortable, healthy, or happy.

4. BONUS INFORMATION

A. Music and the Science of a Life Well Lived

Experiences of pleasure and the sense that life has meaning are vital to happiness. Music, along with sex and food, is among the basic sensory pleasures that contribute to a life well lived, according to the work of Morten L. Kringelbach, a GCBH issue specialist who has long focused on this area. Looked at this way, music is not a luxury or special treat but rather something that fills essential human needs and plays a meaningful role in well-being. Exploring these issues can bring new insights to the science of happiness, leading to greater understanding of how the brain processes pleasure, joy, motivation and reward.

Kringelbach's research suggests that brain mechanisms active in such basic sensations as food and sex are also involved in more sophisticated pleasures, such as appreciation of music and art. Happiness is complex, however, and involves various

B. How Music Contributes to Healthy Aging

For many reasons discussed in this report, music contributes to healthy aging and mental health and well-being through the course of life. It stimulates and activates different parts of the brain – and does so in a powerful manner. By helping people recall memories and connect with their emotions, it

C. Caregiving and Music: An “Unforgettable” Connection

Music offers great possibilities to ease the burden carried by dementia caregivers, yet some may not think of it as a resource. Caregivers often contend with extreme stress that undermines their health and well-being, and even increases their risk of dementia. So it is worth emphasizing that music's healing attributes can apply to caregivers themselves.

Caregivers can also use music as a tool to engage those they care for. They can use it to help keep their loved ones calm, boost their spirits and forge connections to those who have become distant. The anecdotal evidence is powerful. Caregivers report that the right music can transform the demeanor of those they care for, bringing sudden cheer to those who are usually morose. They tell of joyful interactions, such as singing

D. Music Bolsters the Immune System

Among its attributes, music may help us stay healthy. In one experiment, subjects were asked to sing for an hour. Before

elements of the brain's default and pleasure networks. [See *Music Promotes Connectivity in the Brain*.] The link between basic pleasures and higher-level rewards – such as music or altruism – is not well understood.

What is clear is that the pleasures of music may benefit society in ways that go far beyond one individual. Sharing a delight such as music with others encourages empathy, compassion and communication, and may actually increase the pleasure, Kringelbach has noted. Consider the warm and vibrant spirit that may encompass the audience during an intimate recital or choral performance. In these and other ways, music is among the pleasures that contribute to a life well lived.

can enhance the quality of life and contribute meaning to experience. These special traits apply to all people and need not be viewed through a therapeutic lens. At the same time, music also has much to contribute to people who face challenges in brain health, and those who take care of them.

with loved ones, when other attempts to connect have proven futile.

This extraordinary phenomenon is illustrated by a choral group known as the Unforgettables, founded by Mary Mittelman, a research professor at New York University School of Medicine, and a GCBH issue specialist. The Unforgettables is made up of individuals who have Alzheimer's and their caregivers. They practice regularly in a supportive, sociable environment of equals and perform concerts that may include a dozen songs. The shared participation and easygoing connections are rewarding for everyone. It's inspiring to see how engaged the members get in their music, clapping hands and swaying in a unified spirit of happiness.

and after the songfest, researchers measured their blood levels of cytokines – proteins that act as chemical messengers in

the immune system and help regulate inflammation. Singing was found to boost the cytokine levels, a sign that music may strengthen immunity.

You can think of music's ability to boost immunity as a beneficial chain reaction: Music improves people's moods and lowers stress, which affects activity of the autonomic nervous system, which then ramps up the immune function. Studies also suggest that negative feelings undermine the immune function.

E. Music from Long-Ago Remains Part of Us

Whether it's a song your mom used to sing at bedtime, a hit tune from your teen years, or maybe a golden oldie you danced to at your wedding, many of us know firsthand how deeply music can embed itself in our being. We remember lyrics, images and feelings from long ago, and these impressions are backed up by science. Researchers have concluded that musical experiences are powerfully encoded in the human brain.

Not all the effects are identical, however. Music from childhood and adolescence seems to make a deeper, more-lasting impression on memory. In addition, personal favorites stick in our memories longer than music we do not care for. Music that fits with our cultures – a key influence on musical taste

...But Music Hits a Stronger Chord in Some Than Others

Countless kids have chafed at having to practice the piano or another instrument. But the verdict of science favors sticking with it. Evidence is growing that music instruction during childhood helps kids' brains develop more swiftly and yields verbal and language-related benefits that may last a lifetime. And the earlier in life, the better: Studies suggest that music training that starts before age seven pays the greatest dividends. At the same time, researchers are trying to learn more about the benefits of music education later in life, as well.

Research at USC, for example, found that music training in children speeds development in such areas as processing sound, language ability and reading skills, abilities that can help throughout life. The USC study suggests that children who trained in music developed more mature auditory pathways, meaning their brains were more advanced than those of other children in distinguishing sounds, such as changes in pitch and melody.

One trial found that music's effect on immunity was strongest when applied together with a non-music technique that encourages positive emotions. Researchers concluded that such a combined approach is a promising, non-invasive strategy to strengthen the immune system. The findings suggest that music might help people ward off disease, offering some protection for healthy individuals and those with weak immune systems.

from our earliest years – makes a deeper and more favorable impact than music that sounds unfamiliar or odd. And some individuals are just naturally more responsive to music than others.

Yet the childhood connection stands out. Researchers have demonstrated that music activates neural networks within the brain that can evoke very personal, autobiographical memories. Studies using MRI scans have also produced evidence that music associated with the strongest memories sparks the strongest activity in the brain. [For more on the mechanisms, see *Music Awakens Our Emotions*.]

See also research at the NEA Research Lab at Vanderbilt University on the use of music for children with autism and their families: <https://www.vumc.org/music-cognition-lab/social-emotional-development-and-community-building-through-music>.

Research has also shown that music training in childhood may pay off with better verbal memory – the ability to remember words – a skill that may help them thrive in lecture courses, understand information presented verbally and develop better vocabularies, all skills that help people succeed in life.

Brain scans have also shown that musicians develop more gray matter in certain regions, such as those involved in motor and auditory processing. Such structural changes have been linked to enhanced motor and auditory skills. Studies have indicated that pianists' brains respond differently to the sound of piano notes, with more activity in their auditory cortex.

5. DISCUSSION QUESTIONS FRAMING THE DELIBERATIONS

General Questions about Music and the Brain

1. What happens in the brain when you *listen* to music?
2. What happens in the brain when we *create* music?
3. Can listening to music impact a person's ability to think? And how is that related to mood/emotion/mental state?
4. How does singing/creating/listening to music enhance overall well-being? How can music promote social well-being and its relationship to cognitive health?
5. What regions of the brain are dedicated to processing music?
6. How does music contribute to creativity, and how does that affect brain health?
7. Are there high-quality studies that have evaluated the impact of musical activities on cognitive decline in aging? If so, do we know anything about the comparative benefits of musical activity in adults? Is there evidence as to whether musical training, singing, playing an instrument or listening is more or less helpful than another type of musical activity? Is a particular type of music genre (such as jazz or classical) more conducive to reaping the benefits? Or is music paired with movement, or music shared with others more beneficial than the experience of listening by itself?
8. Does listening to background music enhance or harm performance on cognitive tasks?
9. How can music influence the motor functions of the body/help deal with movement disorders? (Note: We will address music's ability to motivate movement/exercise).
10. How does music help the regulation of emotion, mood and depression?
11. What is the impact of music on a neuroendocrine level? Can music boost your immune system?

Questions about the mechanisms of music to impact the Brain

- 12a. How does music elicit the activation of reward pathways in the brain?
- 12b. What are the neural mechanisms underlying the feelings pleasure "hedonia" that one feels when listening to music?
- 12c. Can musical activities train attentional processes to benefit/enhance cognitive functions or treat cognitive deficits? Synchronicity of rhythms (rhythmic entrainment)

Questions about Music and Therapy/Treatment

13. Can producing OR listening to music be used to help treat psychiatric and neurological disorders?
14. What recommendations, based on evidence, can we make about using music as therapy for brain health?

Music and Alzheimer's and Dementia

15. Does playing, singing OR listening music help to build cognitive reserve?
16. Can listening to music [or playing] [singing] delay [or prevent][or treat] dementia and/or cognitive decline? If so, do we know why?
17. In what ways can music play a role in developing interventions for people with dementia?
18. What are community-based interventions that have been shown to effectively engage people with dementia in music? What were measurable outcomes?
19. How is the brain able to experience and react to music even in the later stages of dementia when it can't do other things it used to?

6. DISCLOSURE STATEMENT OF POTENTIAL CONFLICTS OF INTEREST

Twenty-five of the GCBH experts – all of the issue specialists and governance committee members – participating in the formulation of this report were asked to disclose potential conflicts of interest. Twenty-one attested they had no conflicts of interest. Dr. Russo disclosed that his research chair is sponsored in part by a major manufacturer of hearing instruments. Dr. Schlaug disclosed that he holds partial ownership as co-founder of a company that develops apps for diagnosis and treatment of tinnitus. Dr. Petersen disclosed consulting with several pharmaceutical companies. Dr. Yaffe disclosed serving on a data and safety monitoring board for a pharmaceutical company. The authors are unaware of any affiliation of the experts that affected the objectivity of this paper and its recommendations. These disclosures are available upon request by contacting staff of the Global Council on Brain Health.

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9. LIST AND LINKS TO OTHER GCBH REPORTS

All reports are available for download at globalcouncilonbrainhealth.org.

- "The Brain-Body Connection: GCBH Recommendations on Physical Activity and Brain Health"
- "The Brain Sleep Connection: GCBH Recommendations on Sleep and Brain Health"
- "The Brain and Social Connectedness: Recommendations on Social Engagement and Brain Health"
- "Engage Your Brain: GCBH Recommendations on Cognitively Stimulating Activities"
- "Brain Food: GCBH Recommendations on Nourishing Your Brain Health"
- "Brain Health and Mental Well-Being: GCBH Recommendations on Feeling Good and Functioning Well"
- "The Real Deal on Brain Health Supplements: GCBH Recommendations on Vitamins, Minerals, and Other Dietary Supplements"
- "The Brain-Heart Connection: GCBH Recommendations to Manage Cardiovascular Risks to Brain Health"
- "Preserving Your Brain Health During Illness or Surgery: GCBH Recommendations to Prevent and Treat Delirium"

10. SELECT DATA FROM THE 2020 AARP MUSIC AND BRAIN HEALTH SURVEY

Full survey available at: <http://www.aarp.org/musicandbrainhealth>

Adults who report listening to background music more often have higher ratings for some cognitive functions and self-reported brain health

The ability to...	Percent who said each feature of their cognitive function was excellent or very good by frequency of listening to background music			
	All adults	Never	Less than half the time	Half the time or more often
Remember names	48%	41%	46%	51%
Learn new things in general	60%	47%	58%	64%
Finish what you start	55%	44%	54%	57%
How would you describe your...				
Brain health	60%	48%	60%	62%



Even when controlling for age, the more frequently adults age 18 and older listen to background music while engaging in ordinary activities, the more likely they are to rate their ability to remember names, learn new things, and finish what they start as excellent or very good. This same relationship was also noted for brain health.

Q10: What percentage of your day are you passively listening to music (i.e., have music on in the background) while you are engaged in everyday activities? For example, when you are in the car, at home, while you are reading or studying, while exercising, while you are falling asleep, etc. Never, Rarely (up to about 25% of the time), Sometimes (more than 25% of the time up to about 50% of the time), Often (more than 50% of the time up to about 75% of the time), Most of the time (more than 75% of the time to 100% of the time)

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AARP RESEARCH

Country music among favorite genres for adults of all ages

Additionally, popular music is a favorite genre for adults age 18 to 49, rock music is favored among adults age 50 to 64, and classical music is favored by adults age 65 and older.

Adults age 18 to 49



Adults age 50 to 64



Adults age 65+



Q30: What are the top two styles of music that you enjoy listening to (i.e., musical genres/styles)?

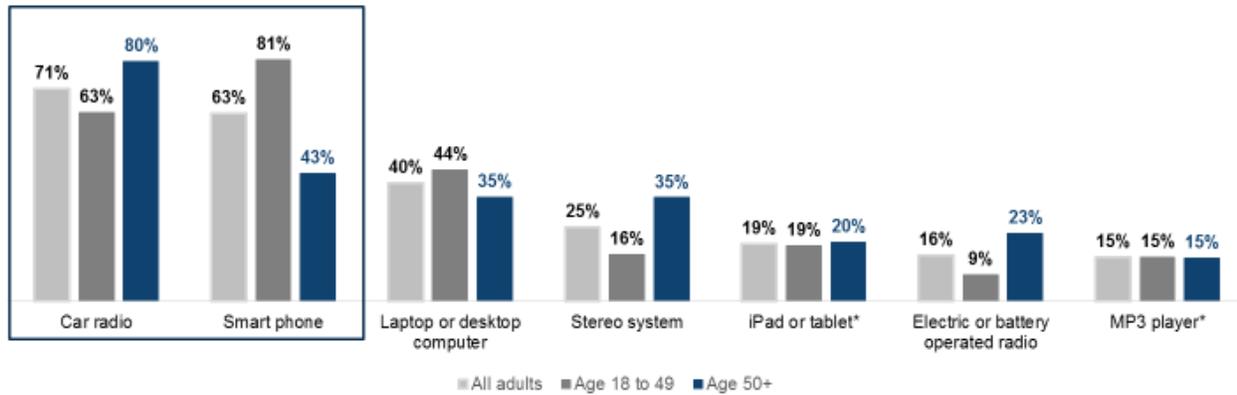
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AARP RESEARCH

Music listening is most common on a car radio and a smart phone

Significant differences were seen between two age groups for the devices commonly used to listen to music. Significantly more adults age 50-plus listen on a car radio, a stereo system, and an electric/battery operated radio. Significantly more adults age 18 to 49 listen on a smart phone and a computer.

Percent who listen to music on each type of device



Q33: On what type of device do you consume music?

* Not statistically significant

11.A PERSPECTIVE ON OLDER ADULT CHORAL SINGERS FROM JEANNE KELLY, FOUNDER OF ENCORE CREATIVITY FOR OLDER ADULTS

Currently serving over 1,300 singers in 23 choral programs in the Maryland, Virginia, DC and NYC area, and 350 older adults singers across the country, Encore Creativity for Older Adults is the nation's largest choral program for older adult singers. Jeanne Kelly founded Encore Creativity after working with Dr. Gene Cohen who led the Creativity and Aging study in 2001. This study aimed to look closer at the effects on older adult singers who had the opportunity to sing under a professional conductor. The study revealed that after 9 months of singing, these singers suffered fewer falls, had fewer doctor and hospital visits, took less medication, and experienced less depression. This landmark study showed that choral singing could make a huge difference in the lives of older adult singers.

Some notable findings Jeanne Kelly points out about her work with Encore Creativity include:

1. Singing brings joy and hope to participants.
2. Participating singers in Encore, ages 55 to 98, are remarkably healthy and resilient. Many remain very physically active through activities ranging from yoga to pickle ball.
3. Encore singers have a strong appetite for learning and challenge, and frequently adopt new skills. They value and understand recommendations for adjusting their singing voice as they age to allow for easier singing.
4. It is observed that Encore singers become interested in other art forms such as museums, opera, and Broadway performances, or getting involved in a new physical activity.
5. Encore singers report less depression; they enjoy their purpose in the organization.
6. Isolation is not a worry for Encore singers. They feel that every rehearsal brings new friendships and opportunities to connect with others. They even enjoy vacationing with fellow Encore singers through Encore camps and concert tours.
7. They value the teamwork that choral singing offers.

Jeanne suggests that the human singing voice could be considered one of the greatest of musical instruments. You do not have to purchase one! She notes that almost all older adults can sing if enough time is given. If every older adult could sing, and better yet, sing under a professional conductor, we would likely have more healthier, happier older adults. Singing can be good for lung health because of the breathing exercise it requires.

Many Encore singers live alone, so that means they speak less, laugh less, articulate less, and have less facial expression. Encore works with them to regain these skills and habits through singing; thus renewing liveliness and hope.

Finally, Jeanne shared a powerful moment that happened during the Encore Sentimental Journey Singers concert. As the care partners entered the concert space with their singers, there was visible stress that they were carrying from caring for a person with Alzheimer's. But when the singing started, the stress dissipated and the care partners appeared to relax. This buttresses the findings Dr. Mittelman shared with her experience with the Unforgettables Chorus. See Appendix 4C.



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