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Opinion

Enhancing Neuroplasticity Is Urgent: Music and Dance for the UN/WHO Decade of Action for Healthy Ageing for All

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Abstract: This descriptive overview responds to a rising tide of reviews and RCTs which encourage evidence-based interventions from the first moments of life and across the life course that could increase the Flynn effect and improve global statistics on neurocognitive functioning with a healthspan that approximates longer lifespans. We need to learn more from our centenarians who achieve Healthy Ageing. Evolving neuroscience empowers us to drive neuroplasticity in a positive direction in ways that are associated with enhancing neurocognitive functioning across the entire lifespan for vigorous longevity. Music and Dance could meet these urgent needs in ways that also have physical, emotional, neurobiological, neurochemical, immunological, and social health benefits. Interventions using Music and Dance are likely to have high initial and ongoing use because people are more inclined to do what is fun, easy, free (or low cost), portable, and culturally adaptable.

Keywords: neuroplasticity; music; dance; review; neurogenesis; aging

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1. Introduction

The UN/WHO Decade of Action for Healthy Ageing focus is urgent, and evolving neuroscience provides sufficient data to be strategic in ways that could increase the use of evidence-based interventions. Throughout life, our complex brains are powerfully changed by experience [1], a process termed neuroplasticity. These neuroplastic structural and functional changes in response to intrinsic and extrinsic factors have positive and negative influences across life. Measurement advancements [2] have increased data on the speed, extent, and diversity of these changes which include, but may not be limited to, increased neurogenesis and integration of these new brain cells; changes in brain volume; increases and decreases of white and grey brain matter; greater complexity of neurons; synaptogenesis; altered global brain circuits; and white matter hemodynamics. Evolving neuroscience empowers the enhancement of neuroplasticity and associated neurocognition.

This descriptive overview's focus is on the findings of associations between neuroplastic changes and improvements in neurocognition. During the 20th century, there have been "massive IQ gains from one generation to another" in 34 countries [3], a finding known as the Flynn effect. Healthy ageing without dementia is achievable [4–7]. A decline in incidence and prevalence of dementia has been found across three decades in individuals who graduated from high school [8]. Driving neuroplasticity in a positive direction with interventions associated with improved cognitive functioning and other health benefits could increase Healthy Ageing from the first moments of life through end of life. It is urgent to include the entire lifespan in considering theoretical approaches and research data that could apply in clinical settings and in the global community to enhance neuroplasticity at all ages for everyone to improve global statistics on neurocognition.

People are surviving longer. Although this raises concern about a greater healthcare burden, including more dementia, "super-cognition" was found in people with an average age of 60.97 whose measured immediate memory, language, attention, and visuospatial abilities were superior; they reported "working more than 9 h/day" at midlife [9].

The growing number of centenarians creates an increasing need for data on evidence-based and age-appropriate interventions as well as suitable measures of neurocognitive status for our oldest old [10]. Healthcare needs to have the goal of increasing the number of people with excellent neurocognition at all ages.

It will always be important to use each of the many categories of interventions that can drive neuroplasticity in a positive direction [11]; however, people are more likely to do what is fun, easy, portable, adapted to their culture, and free or available at a low cost. Since music and dance meet these needs, using music and dance to enhance neuroplasticity could be a preferred international response to the prediction of Brookmeyer and colleagues [12] that, if all we do is delay the onset of dementia by one year, we could have 9,200,000 fewer cases of dementia by 2050.

Not only does evolving the neuroscience of music provide increasing documentation of the neuroplastic purchases of music in healthy people as well as those with compromised brain structure and function; it also finds that music activities are often combined with other lifestyle choices that have been found to improve general health as well as prosocial behaviors across the lifespan [11,13–52]. When hearing music, people tend to move, some dance. There is increasing evidence for the neuroplastic benefits of movement and dance [53–62].

2. Method

Search efforts were primarily within the PubMed database using combinations of keywords above. Periodic searches were conducted between 2015 and 2022. This descriptive overview considers findings on the impact of hearing music, active music making, and dance. Boolean searches within the PubMed database for review articles were limited to 2020 through 2022 and included the combinations of "music AND review", "music AND neuroplasticity AND review", "dance AND review", and "dance AND neuroplasticity AND review". Bibliographies of the articles were searched. Although it's far beyond the scope of this descriptive overview to include all available data, studies reviewed met rigorous scientific standards, were broad review articles or random controlled trials and were included without a specified time span.

3. Results

Receptive music, making music, and dance can be considered as separate categories of influence. This has been observed across the lifespan.

3.1. Receptive Music

Listening to and auditory processing of music involve bilateral and large-scale brain networks, noted on fMRI and PET studies, for encoding, analyzing, appreciating emotional impact and for higher level cognitive functions including attention and memory [38]. Brain networks involved with emotions and reward are more highly activated by familiar than by unfamiliar music. The sound of music activates mirror neurons and the core empathy network with familiar music associated with the strongest response [63]; this fMRI study "confirms and extends empirical claims that music cognition is inextricably linked to social cognition" and could clarify ways that music "can function as a virtual social agent".

Event-related potential (ERP) strength at birth and at 4 months, which were correlated with extent of prenatal music exposure, indicated sufficient neuronal response to sustain fetal memory into early infancy [64]. Simply listening to music has shown positive purchases in the Neonatal Intensive Care Unit (NICU) where preterm infants experience extreme stress [65]. Alleviating stress could protect, perhaps even enhance, neurodevelopment during these early days of life [66,67]; listening to music had some success in reducing this stress [68,69] and might improve memory [70]. A review of studies in five countries [71] found that hearing recorded or live music could improve the heart rate of preterm infants in NICU, stabilize their respiratory rate, decrease stress, and improve oral intake. Longitudinal studies are needed to assess long-term neurodevelopmental effects and to guide clinical treatments in utero and thereafter [69] on the types and duration of musical interventions.

Psychology undergraduate students being trained in spatial reasoning and language processing while listening to Mozart's music in the background increased their speed of processing on both tasks on the third day [15]. Ferreri and colleagues [72] had young, non-musician university students listen to "If you see my mother" by Sidney Bechet; enhanced activation of the dorsolateral prefrontal cortex correlated with enhanced encoding and retrieval in those listening to music.

An RCT [18] looked at the impact of background music in non-musician healthy individuals aged 60–84 in four groups: (1) no music; (2); white noise; (3) Mozart's Eine Kleine Nachtmusik for its high arousal and positive emotion inducement; and (4) Mahler's Adagietto Symphony 5 with lower levels of arousal and inducement of negative emotions. Those hearing the background music of Mozart enjoyed a significant increase in their processing speed. Listening to either Mozart or Mahler as background music was associated with better memory as compared to the groups tested with silence or white noise in the background. These scientists opined that the emotions induced by the music facilitated the memory advantage in these individuals with, on average, 12.29 years of education.

Educational level and small sample sizes are factors; however, these studies invite further research on potential applications across the lifespan and in clinical populations with individuals showing prefrontal impairments, elders, or patients with Alzheimer's.

Another healthy response to hearing music is relief from painful emotions. This includes anxiety [73], depression, and limited personal awareness of emotional status [74] even with patients hospitalized and on antidepressants for major depressive disorder [75]. Listening to music was associated with neurochemical changes associated with reduced stress; these could include increased release of dopamine and endogenous opioids as well as reduced cortisol and beta-endorphin [76]; receptive music compared to silence also was associated with maintaining healthier heart rate and blood pressure during stress. Cortisol is a hormone which helps the body handle stress in part by regulating metabolism, reducing inflammation, improving the immune response, and improving memory. Music interventions have been associated with reducing psychological stress and stress markers such as cortisol [77]. Hearing music has an influence on human genes which "were shown to affect dopamine metabolism and to prevent neurodegeneration" [78]. Community dwelling elders, 65 or more years old had improvements in resisting interference, an important executive skill [26].

Simply listening to music was associated with "increased life engagement and better health" in a dose-related way [79]. Among the over 20,000 Americans aged 50 or more who participated in the 2012 Health and Retirement Study and 2013 Consumption and Activities Mail Survey, 5.3% were high listeners who heard more than 28.6 h of music per week; they reported more hours spent engaging in "sleeping, walking, participating in sports/other activities, engaging in cognitively stimulating activities, and spending greater amounts of time engaged in prayers/meditations as compared to non-listeners". Average listeners also reported greater engagement in these activities than non-listeners. These researchers suggested including music in activities with elders to enhance aging with "direct health benefits". Healthy, active adults expressed less perceived exertion even with increased duration of aerobic exercise when listening to high tempo music [80]. Similarly, musical accompaniment played in harmony with physical exercise has shown significant improvement in psychomotor speed and visuospatial function.in elders [39].

At a six-month follow up with acute stroke patients afforded 2 months of up to an hour of listening to music [38], individuals had improvement in "recovery of verbal memory and focused attention and reducing depression and confusion as well as increasing positive mood, relaxation, and motor activity"; their gains exceeded that of early post-stroke patients who had usual and customary care while listening to audiobooks. Better focused attention, verbal memory, and language skills correlated with grey matter volume increases and structural reorganization in frontal areas of the brains recovering from middle cerebral artery stroke [35]. Six months after their stroke, patients had better memory for stories that were sung to them than the stories that were read to them [81].

Language and music share some cognitive resources, such as working memory [82]; however, musical learning and memory "engages brain networks that are distinct (or more widespread) than those involved in other types of episodic and semantic memory" [38]. The brain "that engages in music is changed by engaging in music" [45,46]; rhythmic sounds of music provide "a physiological template for cueing the timing of movements" which could be accomplished with repetitions of the pairing to compensate and facilitate reshaping neuroplasticity to improve motor function which can be accomplished through rhythmic training of the auditory system for very brief periods resulting in efficient neural impact on motor systems [83].

Care providers were trained in digital technology to create personalized music in the nonprofit organization, Music & Memory [84]. With listening to their familiar music, vast improvements in people suffering advanced dementia included: "(1) Enhanced swallowing mechanism with Music & Memory prior to dining; (2) decreased incidents of choking during mealtime; (3) improved nutritional status; (4) reduced weight loss; (5) reduced need for speech interventions; (6) enhanced quality of life". While elders with dementia listened to familiar music, they were observed to have more eye movement; more eye contact; greater joy; more engagement; increased speech; and decreased sleep, movement, and dancing [27].

Receptive music which improves mood and reduces stress could also reduce aging negative effects while improving the immune response through neurochemical changes [76]. These could include a decrease in interleukin-6 (IL-6), which can have both pro- and anti-inflammatory influence, as well as an increase in growth hormones; moreover, finding increased salivary immunoglobulin A (s-IgA) associated with receptive music is significant since s-IgA is a reliable measure of immune response in the mucosal system.

Elders might also have improved sleep onset, duration, and efficiency after hearing "smooth and wordless" music according to a review of studies conducted in five countries [85]. For some elders improved quality of sleep was realized only after about three weeks of listening to music [86]. Music with a soft volume, slow tempo between 60 and 80 beats per minute, and having a smooth melody has been considered "sedative music" which was more effective than rhythm-centered music to improve sleep quality with adults aged 60 and over who listened to music four or more weeks [87].

In summary, since hearing music activates many cerebellar, subcortical, temporal, and frontal regions as well as multiple networks irrespective of age, musical experience, and training [88], listening to music can be an evidence-based intervention throughout the life course driving neuroplasticity in a positive direction to enhance neurocognition for healthy ageing as well as for modulating pathophysiology. Listening to music has shown significant positive purchase from in utero and premature birth through healthy adults and including elders with dementia at end of life. These have been observed in neurochemical, emotional, behavioral, and cognitive measures and have complex multifocal and multiple brain network involvement.

Neurochemical changes associated with receptive music [76,89] have included increased in oxytocin, dopamine, growth hormone, salivary immunoglobulin A, and endogenous opioids. Researchers also reported decreased interleukin-6 as well as decreased cortisol, the stress and arousal hormone.

Emotional benefits of receptive musical experiences include stress reduction [66] with a more stable heart rate [16,90]; less anxiety [26,73]; less depression and better awareness of emotions [74] even during inpatient treatment for major depression [75]; improved mood [35]; and more joy [27,84].

Behavioral gains associated with listening to music include better feeding in neonates [16,90]; better nutrition through safer feeding of elders with advanced dementia [84]; less agitation, more eye contact, and more talkativeness in adults with dementia [27]; improved motor function in patients who have a movement disorder [91]; increased engagement with exercise [39] and activities of life as well as better health [79] and improved sleep [85–87].

Cognitive gains with listening to music include improved verbal processing and increased speed of processing [15,39,72]; better memory [18,34,36,64,81] and gains in psychomotor speed and enhanced visuospatial functioning [39]. It is significant that all these executive skills are essential in preserving and enhancing cognitive function across the lifespan for healthy ageing.

3.2. Active Music Making

Beginning in infancy, music activities have enhanced cognitive and social skills [22]. Six-month-old infants and their parents participated in a 6-month program of active music making, including percussion instruments. Infant improvements included earlier use of prelinguistic communication and a positive influence on parent–infant social interactions. Researchers opined that infant neuroplasticity is very responsive to musical experiences.

RA review of recent research on music with children 3–12 years old [92] found benefits of music training which included "greater emotional intelligence, academic performance, and pro-social skills". These authors opined that music needs to be included in scholastic activities as an important subject as well as being an educational tool in other academic subjects. Six-year-old children who were given 36 weeks of free weekly training in keyboard or voice [41] showed more increase in Full Scale IQ than peers in drama or no lessons. Because it is very adaptable, this includes immediate feedback, and includes positive feedback of aesthetics and progress, indicating that training in music might be a preferred intervention for improving neurocognition (executive functions) "in a far-transfer" way [93] with "statistically significant far-transfer effects" [94].

The interface between singing and speech requires "binding lyrics and melody into a unified representation"; this activates very complex and bilateral brain networks on fMRI and PET scans [38] and has major implications for clinical applications to enhance brain functions in congenital as well as acquired brain dysfunction. Musical training is an intervention of power which "may facilitate regional brain maturation" as seen in underprivileged children who were living in poverty during the two years of musical training that started when they were 6–7 years old [23]. Activity in the cortex entrained to rhythm and was increased with more years in musical training, which "can be attributed to neural plasticity that accompanies many years of musical training" [95].

Children with an average age of 8.7 who played a musical instrument for more than 30 min a week scored higher on intellectual ability and verbal ability compared to children not playing a musical instrument [96]; intensity of musical practice correlated with their axial diffusivity on diffusion tensor imaging. Researchers opined that "the relationship between musical practice and intellectual ability is related to the maturation of white matter pathways in the auditory motor system" suggesting that "musical training may be a means of improving cognitive and brain health during development".

Youth in the 3rd and 4th grades in elementary school who had social skills deficits were given group music lessons; prosocial skills and sympathy increased whether participants were voluntary or compelled to train [40] suggesting "group music training facilitates the development of prosocial skills". Even with short-term group music training of 20 days [31], 4–6-year-old children measured higher on tests of intelligence; these intellectual enhancements were "correlated with changes in functional brain plasticity during an executive-function task" showing that "transfer of a high-level cognitive skill is possible in early childhood". Children 7–11 years old given a year of music training showed superior improvement in working memory [97]. Adolescents [98] had significant improvement in social skills after 10 weeks of a group music therapy program of singing, drumming, and instrumental improvisation; teaching social skills through "song lyrics and improvisation emerged as salient interventions" for promoting prosocial skills.

Online questionnaire data gathered from 1779 choristers yielded reports of significant physical, spiritual, social, and emotional benefits from singing in a choir [99]. These benefits were significantly greater for professional singers. Music training being positively associated with increased volume in the parahippocampus and inferior frontal cortex suggests that this training affects "a circuit of brain regions involved in executive function, memory, language, and emotion" [100].

Listening to music, singing, and playing an instrument improved episodic memory in healthy adults [34]. Elders using musical improvisation improved their verbal memory [13]. After 12 70-min bi-weekly sessions of improvisational vocal and instrumental exercises, elders in a residential setting with mild to moderate cognitive impairment appreciated significant improvement in cognitive skills in comparison to the control group that had 45-min sessions of gymnastic activities twice a week for 12 weeks and remained stable [101]; this music intervention "improved participants' general cognitive functions, selective attention, planning and logic skills, and abilities related to access and lexical retrieval". Making music together once a month in a music café was a "powerful medium to promote wellbeing for community-dwelling people living with dementia" and for their care partners [102,103]. During the COVID-19 pandemic, music improvisation online helped sustain and enhance community in "Our Virtual Tribe" [30].

Learning to play the piano requires integrating the movements of both hands into a temporal and aesthetic context. Repetition of practice requiring coordination of both hands integrates motor and sensory networks "as well as multimodal integration regions" [104]. It may be that this repetition being reinforced, both immediately and aesthetically, is related to the transfer of gains to many cognitive domains such as perceptual speed, executive functioning, and working memory.

About 40 years after they had stopped instrumental music training of 4 to 14 years duration, adults aged 55–76 demonstrated the fastest neural timing [49]. Adults with less than four years of training in musical instruments had neural timing that was less rapid than the group with more training; however, their speed of neural timing exceeded those with no training. Professional musicians aged 65–90, as compared to non-musician age peers, had better functional connectivity between brain hemispheres with "significantly greater accuracy in tactile interhemispheric transfer" of information and accuracy of response [33]; this is in line with research finding a larger corpus callosum in people with extensive musical training and adds to data indicating that neuroplasticity in aging is positively influenced by music training and is associated with the integration of brain networks.

The above is also in line with findings from the Rush Memory and Aging Project [105] which did yearly assessments of 964 individuals with an average age of 78.7 years, an average of 14.6 years of education, and without cognitive impairment. At first involvement, they were asked about their music and foreign language training. Over six years of yearly evaluations, it is significant that the risk of MCI was about 30% less in those who prior to 18 years of age had four years of music training; it was also about 30% less in those who prior to 18 years of age had more than four years of foreign language training; and, when compared to people who had neither foreign language training nor music lessons before age 18, the risk of MCI was about 60% less in individuals who had more than four years of both foreign language instruction and music lessons before age 18.

Healthy and cognitively intact adults 60–84 years old and naïve to music were given piano training [43]; compared to their own baseline and to other elders who enjoyed different leisure activities, the elders given piano training enjoyed gains in attention, visuomotor tracking, processing speed, motor function, executive skills, positive emotions, subjective wellbeing, and some elements of quality of life. Adults between 64–76 years old had increased bilateral cortical thickness after 6 months of piano training, as compared to those listening to and learning about music, showing cortical plasticity in five auditory-related regions of the brains of older adults [50]. This training stabilized the microstructure of the white matter in the fornix [29]. Older women who had 15 weeks of training in drumming and singing had better memory for verbal and visual information than the same-aged controls who had either language training or no training [106].

After an 8-week piano playing protocol [47], fMRI findings and neuropsychological tests of seven individuals with mild traumatic brain injury (TBI) provided "evidence for a causal relationship between musical training and reorganization of neural networks promoting enhanced cognitive performance". They noted significant differences in activation in the part of the brain that "regulates higher order cognitive processing, such as executive functions". Using 3 months of piano and drum training and musical improvisation, adults with TBI had improved executive functioning which was associated with grey matter structural neuroplasticity in prefrontal areas [107] and rebuilding white matter "structural connectome" [44].

In a comprehensive review of studies that included data on 1757 individuals on several continents, elders with dementia who participated in music therapy "had positive effects on disruptive behavior and anxiety and a positive trend for cognitive function, depression and quality of life" as measured by the MMSE and Self-Administered Gerocognitive Exam [52]. Support for using interactive music intervention to enhance cognitive functioning in elders 65 and older with cognitive dysfunction was found in a review of studies that included 966 participants [51]. A review of recent studies with a total of 495 elders with "probable MCI or dementia" by clinical diagnosis, or whose MMSE scores were "between (and including) 13 and 26", also found improved cognitive functioning after "physically participating in" making music [21].

Music is a complex and multisensory form of enrichment that has a positive influence on neuroplasticity in several regions of the brain [32] because it requires integration of audiovisual information as well as an appreciation of abstract rules [108]. Magnetoencephalography measures with individuals with an average age of 26.45 found that the anterior prefrontal cortex played a central role and that the neuroplastic response was greater in musicians with long term training than was noted in those with short term training [109]. After four months of piano lessons, people aged 60–84 years enjoyed improved mood as well as significant improvements in the cognitive skills of attention, control, motor function, visual scanning, and executive functioning [43]. A review [17] found music training associated with enhanced cognition in a variety of musical and nonmusical skills including creativity and executive functions.

Professional musicians trained to play musical instruments provide an exceptional opportunity for research in neuroplasticity [104]; continuous feedback from auditory, emotional and visual systems integrated with motor responses of practice that is repeated over their years of refining skills facilitates connections between and integration of many motor, auditory, and visual brain regions and networks. Researchers [48] opine "that training of this neural network may produce cross-modal effects on other behavioral and cognitive operations that draw on this network" and that this supports "plasticity-based training in preserving brain functions in the elderly". Studies of musical improvisation, because it seems to include real-time constraints on creativity as well as increased cooperation of far-reaching brain networks, could increase data on maintaining and increasing the positive plastic purchase of musical actions [110,111] which are associated with a "special state of mind, both amongst the performers and their listeners" [112].

Perhaps studies cited above shed light on why playing music many times each week significantly decreased the risk for dementia in a 21-year prospective study [113]. Compared to non-musicians, musicians have better visuospatial memory and conflict resolution suggesting more resistance to interfering memories [14] in musically skilled elders. Orchestral musicians also retained better gray matter density suggesting that their musical activities helped maintain their neuroplastic gains to enhance and preserve cognitive control skills in elders. Elders who had more than 10 years of musical instrument training and practice scored higher than non-musicians in "tests of naming, visuospatial memory, visuomotor speed, visuospatial sequencing, and cognitive flexibility" suggesting that high engagement in instrumental musical activities throughout life could preserve and enhance cognition through advanced age [26].

In summary, researchers have reported that increases in Full Scale IQ [41] and enhanced intelligence [31,96] have been found after active music training. Active music training was associated with improved communication and social skills even as early as the first year of life [22] with some potential for the duration of skills for about 40 years [49]. Cognitive skill improvements found with musical training include speed of processing, memory, attention, academic performance, verbal fluency, and factors of executive functioning; these have been associated with significant neuroplastic changes such as increased bilateral cortical thickness [50]; stabilized white matter microstructure [29]; grey matter structural changes in the prefrontal cortex [107]; rebuilding white matter "structural connectome" [44]; thus, active music training can result in multiple direct benefits to physical, emotional, social, neuroplastic, and neurocognitive healthy aging at any age. It is noteworthy that individuals who had four years of musical training prior to the age of eighteen had a 30% reduced risk of dementia [105]. Reframed in Positive Psychology [114], youth who had 4 years of music training prior to the age of 18 had a 30% higher probability of maintaining neuroplastic and neurocognitive strengths for a longer healthspan compared to youth without music training; moreover noteworthy are the neuroplastic and neurocognitive purchases of making music in elders, healthy or impaired.

3.3. Dance

Hearing and making music, people tend to move; some dance; if their increased exercise is aerobic, this could increase neuroplastic and neurocognitive benefits [55,115,116]. Although long-term frequent receptive and active music making are efficient ways to reduce the risk of dementia, frequent dancing adds complexity which could afford better long-term retention of neurocognitive functions and brain structure. Recent reviews and RCT studies support this perspective. Positive neuroplasticity has been noted in both grey and white brain matter after long-term dance training [117]. Dancing and drumming from 30 min to 1 h weekly also resulted in health benefits [118].

In his review of 12 studies of healthy people aged 59 or older, Nascimento [58] found that "dance practice was associated with an improvement in functional connectivity, cognitive performance, and increased brain volumes". With regular dancing of sufficient intensity, several regions of the brain benefitted from the increased use of visual, auditory, motor, and executive functions required to move in space to rhythm and others in the environment. Improvements were noted in "cognition, attention, executive functions and memory"; neuroplastic changes can "significantly increase and also preserve the performance of the functional capacity (postural control, walking speed) of older adults, contributing to their autonomy and quality of life" [58].

A small RCT [119] with healthy people more than 60 years old compared a control group living "life as usual" to a 60 min, 3 times a week, dance intervention group. Irish country, African, Greek, and other types of dances were included with medium physical intensity; enhanced brain activity on resting state fMRI with the dance intervention correlated with improved attention and executive functions. Depression in people with MCI and dementia was reduced with dancing [120]. Traditional dances of India improved balance and motor skills more than neuromuscular training in "children with Down syndrome" [121]; the benefits of dance can also be facilitated remotely [122].

A review of 5 random control trials with 358 participants who had MCI found better "global cognition, attention, immediate and delayed recall, and visuospatial ability" after one to three weeks of Latin ballroom and aerobic dances with light to moderate intensity [54]. Researchers opined that increased neurotrophic factors, such as BDNF, as well as increased growth factors, could have mediated the improved neuroplasticity. Dances were culturally adapted, and participants danced with a partner or in groups adding social interaction to the equation which adds a socioemotional factor [53] that warrants being measured. Another review of 11 RCTs with 1412 healthy participants aged 55 and older [56], supports the theory that dance improves function of global cognition as measured by the MMSE and MOCA. Larger improvements were noted in dancers with MCI.

Assessing the impact of dance on elders diagnosed with MCI [61], reviewers only considered RCTs which included control groups. Neurocognitive purchases of the dance interventions included significant improvements in global cognition; physical function; memory; language; and visuospatial function.

Memory improvements associated with dance interventions with or without MCI might be related to the increased hippocampal volume that has been reported in dancers [59]; it might also reflect aerobic exercise effects of improved neuroplasticity in white matter in the brains of healthy elders [116]. Since music and dance share similar neural correlates [117], mastery in each of these activities has shown positive neuroplastic purchase. The lack of information on the intensity of exercise in aerobic dance interventions was also noted [62] in the review of 5 RCTs with 842 elders with MCI; global cognitive functioning and memory improvements were significant, with some gains in executive function.

In summary, despite limitations such as sample size, heterogeneity of research design and subjects, limited data on dance intensity and/or duration, reviewers and researchers opined that providing dance activities for people could enhance neuroplasticity for structural, neurochemical, functional, prosocial, and neurocognitive gains while potentially improving physical health. Thus, providing group dance events could be an important, inexpensive, and nonpharmacological way to bring these benefits to our global citizens.

4. Discussion

The UN/WHO Decade of Action for Healthy Ageing is timely, the focus is urgent, and evolving neuroscience provides sufficient data to be strategic in ways that could increase the ongoing use of evidence-based interventions to enhance neuroplasticity and neurocognition from the first moments of life and throughout the life course. People are more likely to do what is fun, easy, portable, adapted to their culture, and available at low to no cost. Music and dance meet these parameters and can enhance neuroplasticity in ways that improve physical, emotional, neurocognitive, immunochemical, and social health to bring change within seconds that can endure decades potentially "stimulating social sustainability" [123]. Music and dance can be provided remotely.

Hearing soothing music benefits neonates [68,69,71,124,125] in ways that might protect and enhance their neurodevelopment [65,66]. Learning is enhanced [15,72]. Emotional, neurochemical, behavioral, and neurocognitive benefits which are essential for healthy aging have been noted across the lifespan through end of life including with severe dementia [27,84–86].

Actively making music has been associated with enhanced intelligence [31,41,96] with neurocognitive and social gains for infants [22] as well as in elders [21,47,51,52]. High engagement in instrumental music activities throughout life could preserve and enhance neurocognition through advanced age [25]; gains can endure for 40 years [49]. It is significant that people who had 4 years of musical training prior to age eighteen had a 30% higher probability of maintaining their neuroplastic and neurocognitive strengths for a longer healthspan as compared to youth without music training [105].

Dance affords significant improvements in brain chemistry, architecture, and performance such that physical health, neurocognition, and physical function can be maintained for a better quality of life [54,56–61,72,118,119,126]. "Dance showed a better effect for structural and functional changes in the brain" than music and exercise [58].

All things considered, despite limitations expressed above such as sample size and heterogeneity of studies, subjects, and measurements, data suggest that providing piano lessons to groups, such as in a community center, could be an affordable and easily accessible use of leisure time to enrich and inspire elders in quest of successful ageing to engage in activities that might maintain, and indeed perhaps enhance, their cognitive skills. When these community events could facilitate dancing, which many people do at the sound of music, significant neuroplastic and neurocognitive benefits could be realized in ways that might also improve social, physical, and emotional healthy aging.

Further research needs to study long-term behavioral, social, neurocognitive, and neuroplastic purchases to assess the capacity of Music and dance in groups to enhance the Flynn effect in nonpharmacological ways that are fun, easy, portable, culturally adapted, and free or available at a low cost. Dancing includes increased complexity of movement which induces functional and structural neuroplasticity [58]. Research reviewers [56] opined that greater intensity and longer duration of dance interventions could yield more neurocognitive benefits in health and dysfunction; adding meaning and purpose to these interventions could increase adherence, social connections, and factors of empowerment and energy. Longitudinal studies to assess this need to have rigorous design parameters with episodic measures of neuropsychological performance; biological markers; neuroimaging of changes in structural and functional neuroplasticity; psychosocial function; emotional status; physical function; and perceived quality of life.

5. Conclusions

Although small sample sizes, heterogeneity of studies, and limited details on such variables as the duration of interventions and intensity of dance limit interpretation of data, evolving research has shown that music and dance drive neuroplasticity in a positive direction with associated neurocognitive and health benefits while music and dance are also environmentally safe; these benefits can be noted from the earliest moment of human life and across the lifespan including our oldest old as predicted by Marian Diamond, the mother of neuroplasticity [1].

Research supports encouraging the use of soothing background music at all ages in most settings. The sound of calm music can promote health and improved functioning as early in life as in the NICU, during severe dementia at end of life, and at all life stages between. Actively making music can promote social, emotional, and behavioral health as early as the first year of life. Dance and music can drive neuroplasticity in a positive direction across the entire human lifespan in ways that promote emotional, social, physical, and neurocognitive Healthy Ageing including increases in scores on intelligence tests. This is not to suggest that music and dance are a panacea; all previously described lifestyle choices [11] remain essential for Healthy Ageing.

It is noteworthy that evolving neuroscience suggests that group activities with Music and Dance could enhance neuroplasticity in the many ways that could increase the Flynn effect for our global citizens; these gains in intelligence and neurocognitive skills might prevent, delay onset, and/or reverse dementia. These efforts could improve global statistics on neurocognitive functioning in more than the 34 countries previously documented by Flynn and influence a vigorous longevity with a healthspan that approximates longer lifespans, perhaps improving the quality of life in more centenarians. Since music and dance can be fun, easy, portable, culturally adaptable, available for free or at low cost, and included with other factors that enhance neuroplasticity [11], group musical events which can include dance could be a preferred response throughout the UN/WHO Decade of Action for Healthy Ageing and beyond.

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