# Developing an Intergenerational Music Program Delivered by Adolescents to Older Adults with Alzheimer's disease and Dementia

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Submitted to the Graduate Faculty of the

School of Health and Rehabilitation Sciences in partial fulfillment

of the requirements for the degree of

Doctor of Philosophy

University of Pittsburgh

2022

UNIVERSITY OF PITTSBURGH

SCHOOL OF HEALTH AND REHABILITATION SCIENCES

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University of Pittsburgh, 2022

The number of older adults living with Alzheimer's disease or Alzheimer's disease-related dementias (AD+ADRD) is rapidly increasing. AD+ADRD can dramatically alter the cognitive, emotional, and social aspects of a person's life. Music is a unique nonpharmacological intervention that has been shown to support these critical areas for people living with AD+ADRD. While early studies suggest that music could be a powerful modality, music has been part of science's replication crisis.

The focus of this dissertation had three aims: First, we conducted a comprehensive review of the literature related to active music for older adults living with AD+ADRD and classified music activities used. We determined that active music supported cognitive functioning in older adults living with AD+ADRD and showed promise to support emotional well-being.

Second, we assessed the potential of adolescent musicians to deliver Project Unmute, a digital active music intervention for older adults living with AD+ADRD. To assess the fidelity of the intervention, the research team measured attendance, preparation of the intervention, and adherence in delivering the intervention. The eight adolescents achieved 100% attendance, 100% preparation, and 100% adherence. This research suggests that adolescent musicians have the potential to administer a well-defined music intervention with high adherence and that they attend and prepare for the intervention training sessions.

Third, we conducted qualitative in-depth interviews with the adolescent participants to create an understanding of their characteristics and experiences. For experiences, adolescents reported decreased performance anxiety and an increased ability to think on their feet. Additionally, they reported an increase understanding of AD+ADRD. There is potential for future researchers to explore if adolescents who facilitate such a music intervention experience less performance anxiety as well as more empathy for older adults living with AD+ADRD.

These findings advance our knowledge in the fields of music and rehabilitation to better understand the effects of active music and the potential for adolescents to facilitate music interventions for older adults living with AD+ADRD. These findings have implications for a scalable program of adolescent musicians who can consistently deliver a digital active music program to millions of older adults living with AD+ADRD.

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## Preface

There are many people who supported this dissertation work. I would like to thank my mentor Juleen Rodakowski, OTD, MS, OTR/L, for her guidance and support throughout the past four years. I am grateful to the other members of my dissertation committee, which include Ketki Raina, PhD, OTR/L, Laurent Terhorst, PhD, and Stephen Neely, PhD. They offered invaluable support and expertise to this dissertation. I would like to extend my sincerest gratitude to our community partners, Dementia360 and the Milton Academy. They were instrumental to aid in recruiting and supported the program from beginning to end. I appreciate the eight adolescents who participated in this research study for their time and effort. I am grateful for the research support provided by Laura Waterstram, Josh Woolford, and the Prosper in Participation laboratory. I thank the Fishbowl, CoBALT, and colleagues within the Department of Occupational Therapy for the moral support. My dissertation was supported by the National Institute on Aging (R01AG056351) and the National Endowment for the Arts (1891751-38). Finally, I would like to thank my family and friends. Special thanks to Patrick Doyle and Karen and Dan Doyle for their unending support.

# 1.0 Introduction

## 1.1 Significance

### 1.1.1 Outcomes for Alzheimer's Disease and Alzheimer's Disease-Related Dementias

The number of adults living with Alzheimer's disease or Alzheimer's disease-related dementias (AD+ADRD) is escalating rapidly.[1] Dementia affects 55 million people worldwide, and that number is projected to increase to 139 million people by 2050 due to a growing aging population.[2]

AD +ADRD can have a devastating diversity of outcomes, including cognitive decline,[3] changes in emotional well-being,[4] and decreased social connection.[5] Understanding how to mitigate these consequences of the disease early is critical because these same factors – cognition, emotional well-being, and social connection -- may be protective of cognitive decline for those with a dementia diagnosis. Epidemiological evidence suggests that participating in cognitive activities is associated with a delayed onset of memory decline.[6] Factors of emotional well-being – quality of life and depression – have been associated with improved cognition.[7] Social engagement may be mentally stimulating and delay cognitive decline.[8,9] Pharmacological treatments have not yet proven to slow cognitive decline or support emotional and social changes[1] and many non-pharmacological treatments have not shown influence in all areas of decline.

### 1.1.2 Music's potential as an intervention

Music is a nonpharmacological intervention that has demonstrated potential to slow decline in all three areas of decline in older adults living with AD+ADRD: cognition,[10] emotional well-being, [11] and social connection.[12] Music is a modality that stimulates multiple regions of the brain simultaneously,[13] and has been shown to promote neuroplasticity in both healthy adults and those with brain impairments.[14] Music activates the reward circuits of the brain via the auditory region, causing pleasure.[15]

While early studies show powerful promise in supporting key outcomes for those living with AD+ADRD, music intervention research has been part of science's replication crisis. Due to the lack of clear reporting on the protocols used in music research, many of its specific music activities are unknown and cannot be repeated. This leads to a lack of understanding as to what components of music may be able to support positive outcomes.[16] It is important to test and report on a consistent protocol so that future studies can replicate the intervention and the program has the potential to be implemented in the community. Most importantly, the ability to test a consistent protocol will inform researchers' understanding of the benefits of music and how they may be able to support the lives of the millions of older adults living with the disease.

### 1.1.3 Approaches to understanding music's potential

It is critical to take a systematic approach to developing and assessing music interventions to elucidate what music activities may be able to support positive health outcomes for those living with AD+ADRD.[16] To design music interventions for older adults living with AD+ADRD, it is crucial to understand and clarify what music "ingredients" have been used in past music

interventions. Ingredients are the specific activities that can cause changes in outcome.[17] One of the first opportunities for understanding is to clarify whether music interventions are using "active" or "passive" music. Active music has been defined as "interactive engagement in music," while passive music has been defined as "listening to music."[18] More specifically, individual music activities have been taxonomized in the Reporting Guidelines for Music-based Interventions.[16] The Reporting Guidelines for Music-based Interventions offer a comprehensive reporting checklist for interventions, including specific descriptions of music activities, such as "re-creating music by singing or playing musical instruments," "improvisation," and "listening."[16] The Reporting Guidelines add value by creating consistent and clear definitions to categorize music activities, helping researchers clarify what specific activities may be associated with positive outcomes. To our knowledge, music interventions for older adults living with AD+ADRD have not been reviewed and analyzed using the Reporting Guidelines for Music-based Interventions. This work is crucial to understand what musical activities have been utilized in previous research to inform the development of subsequent music interventions.

Additionally, an opportunity exists to understand the potential of future music facilitators of music interventions. The Reporting Guidelines for Music-based Interventions acknowledge this, asking future research to detail the qualifications of the facilitators of the intervention.[16] Doing this is important so that researchers can control for potential therapist effects on music interventions, meaning that the delivery of the intervention by the therapist could be different enough to affect outcomes.[19] For implementation, it's also critical to understand who may be able to deliver a music intervention to recruit and train new music facilitators.

Intergenerational program design has begun exploring the potential for young generations to both participate in and facilitate arts interventions. Intergenerational music programs have been

shown to benefit older adults' quality of life and social connection[20] and generational perceptions of both children and adults.[21,22] Programs have been designed for younger children[23,24] and have been facilitated by college students.[25] Though a recent multi-disciplinary arts intervention for adolescents and older adults showed promise in self-awareness and empathy for both generations,[26] a paucity of research explores adolescent musicians' potential to facilitate a music intervention for older adults living with AD+ADRD. In particular, utilizing adolescent musicians in such a design could yield critical support for this young generation in a vulnerable time of transition, as music influences their emotional well-being[27] and self-esteem.[28] A gap exists to explore the potential for adolescents to implement clearly defined music activities for older adults living with AD+ADRD.

To assess the potential of a clearly defined digital active music intervention, it's critical to use the understanding of the state of the science to utilize music activities that may cause changes in outcomes. Once key ingredients are identified, the Developing Complex Interventions Framework provides development guidance for multi-faceted interventions, such as music, that have several interacting components.[29] A critical step of assessing a clearly-defined digital active music intervention is to test fidelity, which confirms that the specific music activities are feasible and can be delivered consistently[30] by young music facilitators.[28,31] With a paucity of research exploring adolescents' ability to facilitate music interventions, it is important to test their ability to deliver a protocol consistently, and to report on their fidelity and the intervention itself using the Reporting Guidelines for Music-based Interventions. Clarifying the adolescents' consistency and the specifics of music activities utilized will help future research understand what music activities are associated with positive outcomes for older adults living with AD+ADRD.

Additionally, knowing that intergenerational programs have been shown to benefit both younger and older generations, a gap exists to understand adolescents' characteristics and experiences in delivering a music program to older adults living with AD+ADRD. As discussed in feasibility methodology,[31] principle data collection should include qualitative methods with stakeholders. A qualitative inquiry that examines adolescents' characteristics and experiences is critical. Exploring characteristics will help future researchers understand the qualities of adolescents who are successful in delivering the intervention, as well as the potential for generalizability of a more diverse pool of adolescents to deliver the intervention. Understanding the adolescents' experiences in delivering the intervention is critical to inform subsequent iterations of the intervention design with stakeholder feedback.[29]

### 1.1.4 Framework to understand and systematically develop music interventions

The Developing Complex Interventions framework, developed by the UK Medical Resource Council, provides guidance on development, evaluation, and implementation of complex interventions like music, which have a multiple interacting components.[29] Our proposed research follows its Development guidance, which suggests identifying the evidence base, and its Feasibility/Piloting guidance, which suggests testing procedures.[29] As suggested by the framework, this approach is systematic and iterative, meaning information gleaned from the Development phase will inform the intervention assessed in the Feasibility/Piloting phase, and information learned from the Feasibility/Piloting phase will influence future development of the intervention.

This proposal has three aims that follow the methods of Developing Complex Interventions Framework:[29]

## 1.2 Specific Aims

The **objective of this dissertation** is to advance our understanding of the music intervention activities that may support the cognitive, emotional, and social outcomes for older adults with AD+ADRD, assess a clearly defined digital active music intervention for fidelity, and understand the characteristics and experiences of its young facilitators. This work is critical because AD+ADRD are affecting millions of older adults and music is a safe, engaging modality that has demonstrated the ability to support critical outcomes of both older adults and adolescents. This work will be accomplished through three aims:

Aim 1: Examine the current state of the science of active music interventions that seek to support cognitive functioning, emotional well-being, and social engagement in older adults with AD+ADRD **(Chapter 2).**

Aim 2: Assess fidelity of adolescent musicians in the delivery of a digital active music intervention to older adults living with AD+ADRD **(Chapter 3).**

**Aim 3:** Assess the characteristics and experiences of adolescent musicians regarding the delivery of a digital active music intervention to older adults with AD+ADRD **(Chapter 4).**

## 1.3 Innovation

This dissertation is **innovative** as it utilizes a systematic approach to advance the area of music interventions. It elicits an understanding of the effects of active music interventions on older adults living with AD+ADRD and categorized music activities. It explores if a digital active music intervention can be delivered consistently, laying the groundwork for future testing of a clearly

defined protocol. Additionally, it creates a comprehensive understanding of the adolescent musician facilitators, including their characteristics for future implementation, their experiences for identifying outcome measures, and their opinions to inform intervention iteration. The proposal is **significant** as it lays the groundwork for future research to explore the potential impact of delivering a digital active music intervention for the adolescent facilitators during a vulnerable time in their development. These findings have implications for a scalable program of adolescent musicians who can consistently deliver a digital active music intervention, potentially providing cognitive, emotional, and social support to millions of older adults living with AD+ADRD.

# 2.0 Effects of Music Participation for MCI and Dementia: A Systematic Review and Meta-Analysis

## 2.1 Introduction

Dementia is a debilitating disease that can dramatically alter the cognitive, emotional, and social aspects of a person's life. Worldwide, around 50 million people have dementia. That number is projected to rise to 152 million people by 2050.[2] Additionally, 15% of older adults without Alzheimer's Disease likely have Mild Cognitive Impairment (MCI),[32] a preclinical state between normal cognitive aging and Alzheimer's disease. Up to 38% of these adults will go on to develop Alzheimer's within five years.[33] The early stages of dementia and Alzheimer's can have devasting outcomes, including cognitive decline,[3] changes in emotional regulation,[4] and decreased social engagement.[5]

Mitigating these consequences of the disease is critical; these same factors may be protective of cognitive decline and slow the progression of the disease, though best strategies are still being discovered. Participating in cognitive activities are associated with a delayed onset of memory decline, [6] factors of emotional well-being such as improved quality of life have been associated with improved cognitive functioning,[7] and social engagement may be mentally stimulating and delay cognitive decline.[8,9]

Music is an intervention that has shown potential to influence critical outcomes but could benefit from clearer reporting of its specific music activities. Previous reporting of music interventions' activities lacked precision. Music interventions were categorized in one of two

ways: as either active, in which participants are actively participating in the music-making process, or receptive/passive, in which they are listening to music, typically for relaxation or changes to mood. [34,35] There was often a lack of reporting clarity as to specific music activities utilized, leaving future researchers unable to duplicate the intervention or understand what activities may have caused the effect. A more detailed categorization system, the Reporting Guidelines for Music-based Interventions, identifies activities such as learning a previously composed song or improvising new music. [16,36] Little research employs these guidelines to classify music interventions for older adults with MCI or dementia.

The objective of this systematic review and meta-analysis is to assess the effects of active music interventions, as defined by "physically participating in music," compared to controls on cognitive functioning, emotional well-being, and social engagement for older adults with probable MCI, mild, or moderate dementia. Additionally, this review will examine and categorize the specific music activities employed by each intervention.

## 2.2 Methods

### 2.2.1 Protocol and registration

This systematic review and meta-analysis followed the publishing guidelines as set forth by PRISMA[37] and was registered with PROSPERO (registration number CRD 420201167390).

### 2.2.2 Eligibility criteria

Eligibility criteria and methods of analysis were determined *a priori* and were included in the protocol. Required studies had to focus on active music interventions with participants over 65 who have probably MCI or dementia. This was defined by either a clinical diagnosis of MCI, mild, or moderate dementia and/or scores between (and including) 13 and 26 on the Mini-Mental State Examination, excluding severe dementia with scores lower than 13.[38,39] The intervention had to be based on active music; those interventions that were both active music and pharmacological were excluded in the search strategy. Lastly, outcomes reported must have included cognitive functioning, emotional well-being, or social engagement. Assessments included clinical and self-report measures. Emotional well-being was defined by the domains of quality of life, mood, depression, and anxiety. Only randomized controlled trials reported in English-language journals and published 2000 through 2021 were included; comments, editorials, dissertations, conference proceedings, etc. were excluded. Non-randomized trials and other interventions as well as cross-sectional, case-control, cohort studies, and cases reports were excluded.

### 2.2.3 Information sources

APA PsycInfo (Ovid), *Medline* (Ovid), *Embase* (Ovid), and *CINAHL* (Ebsco) were searched; a health sciences librarian with systematic review experience developed all searches. [40] The date of the last search was March 15, 2021. Concepts that made up the searches were: cognitive decline, older adults, and music therapy. A combination of American Psychological Association thesaurus terms and title, abstract, and keywords were used to develop the initial PsycINFO search which was checked against a known set of studies. The search was then adapted

to search other databases. A sample search strategy and date searched for each database is provided in Appendix A.

Bibliographies of relevant articles were examined by the first author for studies not found through database searches. EndNote (Clarivate) was used to store all citations found in the search process and to check for duplicates. Search strategies and results were tracked using an Excel workbook designed specifically for this purpose. [41]

### 2.2.4 Study selection

Study selection was conducted in EndNote. Two authors independently reviewed articles and held weekly meetings to resolve issues. Discrepancies were resolved through team discussion.

Two authors met to compare studies based on characteristics of the interventions and analyzed the music intervention components to confirm they were conceptually similar for the meta-analysis. An author analyzed the studies for similar risk of bias using the Revised Cochrane risk-of-bias tool (RoB2) for randomized trials. [42]

### 2.2.5 Data collection process

Data were extracted; authors were contacted to obtain and confirm data. Data were extracted on the basis of study characteristics (type of study, year published, author, name of study), population characteristics (mean age and gender), disease severity (MCI, mild or moderate dementia), intervention content as specified by Robb (2011, 2018), interventionist training, duration, frequency, sample sizes, and outcome measures in global cognitive functioning, emotional well-being, and social engagement, as defined by social connection and/or support. Due

to the known heterogeneity of the music intervention protocols, cognitive functioning was assessed globally. Data were collected at post-assessments, immediately following the intervention. The studies were summarized according to the abstraction process listed above.

### 2.2.6 Assessment of Risk of Bias

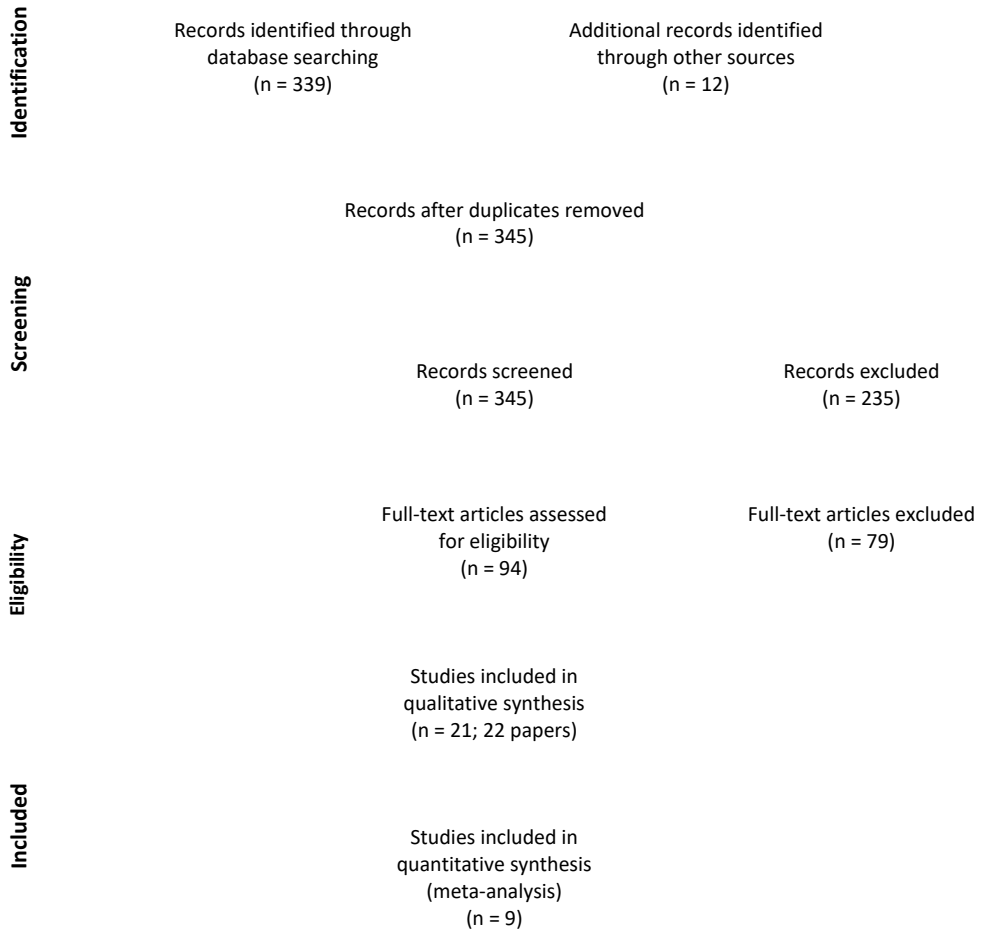
Each of the included studies was assessed for its risk of bias in terms of random sequence generation, allocation concealment, baseline differences between groups, blinding of participants and personnel during the trial, measurement of the outcome, incomplete outcome data, and selective reporting. The criteria used for judging each item were based on those provided in the Revised Cochrane risk-of-bias tool (RoB2) for randomized trials. [42] Using the RoB2 allowed for better representation of the risk of trials where blinding the participants to the interventions, for example, is an impossibility.

### 2.2.7 Summary measures

Studies were categorized by type of music activity. Effect sizes were calculated if means and standard deviations were included; if not, authors were contacted via email to obtain the information. Cohen's criteria was used for standardized mean differences (SMD $\geq 0.20$ and $< 0.50$ is considered small, SMD $\geq 0.50$ and $< 0.8$ is considered medium, and SMD $\geq 0.8$ is considered large). [43] The software "RevMan 5.4" [44] was utilized to calculate the standardized mean difference between the experimental and control groups of each study included in the meta-analysis.

### 2.2.8 Selection for meta-analysis

Studies were selected due to using active music interventions, utilizing similar study designs and employing similar outcome measures. Where applicable, the team selected the more active of the two control groups as the comparison group, such as exercise, an emerging potent modality that may be synergistic to understanding music's potential. The team selected only studies which randomized by the individual to include in the meta-analysis. The research team evaluated the treatment effects using random-effects models because the statistical inference intention was generalization inference, there were more than five studies, and the research team believed that each study was estimating a different underlying true effect.[45] To that end, the study team found that there wasn't a true or common effect across interventions because while the people administering the intervention were similar, they weren't identical in training. The dosage was similar but did range from six weeks to six months. Finally, the music activities were similar in that they were active music, but ranged to include other activities, like art and horticulture. Following Cochrane's guidance, it was concluded that there would be variation in the intervention effects.[46] The I2 test [47] was used to evaluate heterogeneity, and funnel plots were used to evaluate publication bias. The research team followed the pragmatic approach that researchers can assess both fixed and random-effects meta-analyses for funnel plot asymmetry and proceed with a random-effects meta-analytic model if there was no evidence of asymmetry.[46]




*From:* Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

**Figure 1. PRISMA diagram.**

## 2.3 Results

### 2.3.1 Study identification and selection

The results of the search strategy are listed in Figure 1. The systematic literature search identified 339 records, and an additional 12 records were identified through published, relevant systematic reviews. After duplicates were removed, 345 records were considered. Of these, 21 studies (22 papers) met the eligibility requirements and were included in the systematic review, and nine studies were included in the meta-analysis.

### 2.3.2 Characteristics of the studies

A summary of the 21 studies is detailed in Appendix B.

### 2.3.3 Participants

The 21 studies included 1,472 participants. Trials were published from 2010 to 2021. The mean age in studies ranged from 68.9[48] to 87.9[49] years old.

### 2.3.4 Study Design

All studies were randomized control trials. Three studies utilized cluster randomization [50,51,52] while the rest randomized by the individual participant. Two were multi-center designs, [53,54] and two were cross-over designs. [55,56]

### 2.3.5 Intervention

Consensus was reached that all studies included active music, as defined by "physically participating in music." Musical training did not influence recruitment or volunteering of participants. Interventions ranged in duration from four weeks[49,55] to 40 weeks.[57] Sessions were from 30 minutes[50,58,59] to two hours[53] in length and happened from once a week[50,53,57,60-63] to five times a week.[55,64,65] The interventionists were all specialists but ranged in experience from psychologists with musical expertise[66,67] to music therapists,[49-51,54,55,58-61,64,68,69] occupational therapists,[55,64,65] and professional musicians.[52,53,56,57,61,63] In terms of Robb's Reporting Guidelines,[16,36] seven studies utilized Listening, 17 studies utilized Re-Creating Music by Singing/Playing Instruments, 10 utilized Improvisation, six utilized Movement, one utilized Imagery, one utilized Breathing Entrainment, and two had other characteristics: Ceccato (2012) created attention exercises where participants reacted to a stimulus, such as clapping when hearing a drum but refraining when hearing a drum preceded by a cymbal, and Chen (2018) created dual task training, where participants cued their sound from different stimuli. See Appendix C.

### 2.3.6 Methodological quality of studies

Of the 21 trials included, 18 trials were found to be low risk, [48-51,53-58,60,61,66-71] and three had "some concerns" (See Appendix D). Three out of the 21 trials did not clearly indicate if the allocation concealment used a remote or external party to allocate interventions to the participants, and thus were classified as "no information." [52,64,65] In addition, one study used randomization sequence generation, but the randomization procedure was unclear. [52]

### 2.3.7 Outcomes

For studies assessing global cognitive functioning, eleven studies utilized the Mini-Mental State Examination. [48,52,54,57,58,61,66-69,71] Two studies utilized the Korean Mini-Mental State Examination, [64,65] one study used the Frontal Assessment Battery,[53] one used the Alzheimer's Disease Assessment Scale cognitive subscale,[53,71] and one study used the Cognitive Mini Examination.[55]

Emotional well-being was parsed into the categories of quality of life, mood, depression, and anxiety. For studies assessing quality of life, four studies utilized the Quality of Life in Alzheimer's Disease questionnaire,[49,51,61,64] one used the Geriatric Quality of Life-Dementia,[72] and one used EQ-5D.[53] For studies assessing mood, one study used the Positive and Negative Affect Schedule,[49] one study used the Cornell Brown Scale-Mood Related Signs,[61] and the last utilized the Participation Engagement Observation Checklist.[56] Eleven studies measured depression; one used the Beck Depression Inventory,[68] one used the Depression subscale of the Neuropsychiatric Inventory Questionnaire,[69] one used the Cornell Scale for Depression,[58] one used the depression subscale of the Hospital Anxiety and Depression Scale,[51] one used the Short-Form Geriatric Depression Scale-K,[73] and six used the Geriatric Depression Scale.[53-55,63,64,67] Five studies assessed anxiety; two used the State Trait Anxiety Inventory,[53,68] one used the anxiety subscale of the Hospital Anxiety and Depression Scale,[51] one used the Hamilton Anxiety Rating Scale,[74] and one used the Anxiety subscale of the Neuropsychiatric Inventory Questionnaire.[69] Social connection was measured in two studies, and both utilized the Lubben Social Network Scale. [68,69]

### 2.3.8 Effect of music in older adults with probable MCI or dementia

### 2.3.9 Meta-Analysis of cognitive functioning

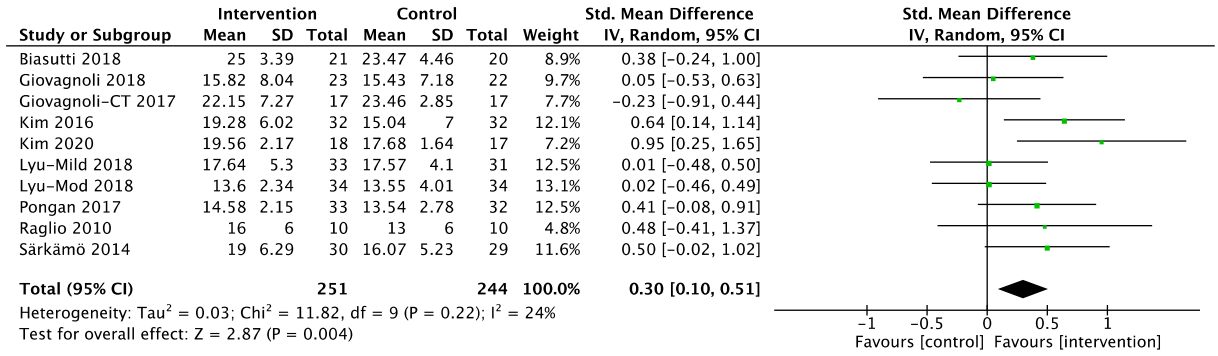



**Figure 2. Meta-analysis of effects of active music vs control groups on cognition.**

Of the 21 studies, nine studies recruiting a total of 495 participants were used to produce a random-effects meta-analytic model for cognitive functioning. The combined SMD for the experimental and control group was 0.30, [95% confidence interval (CI), 0.10, 0.51], Figure 2. There was low study heterogeneity, with an I2 of 24% (p=.004). In assessing the symmetry of the studies' funnel plots, publication bias was not detected. (See Figures 3 and 4.)

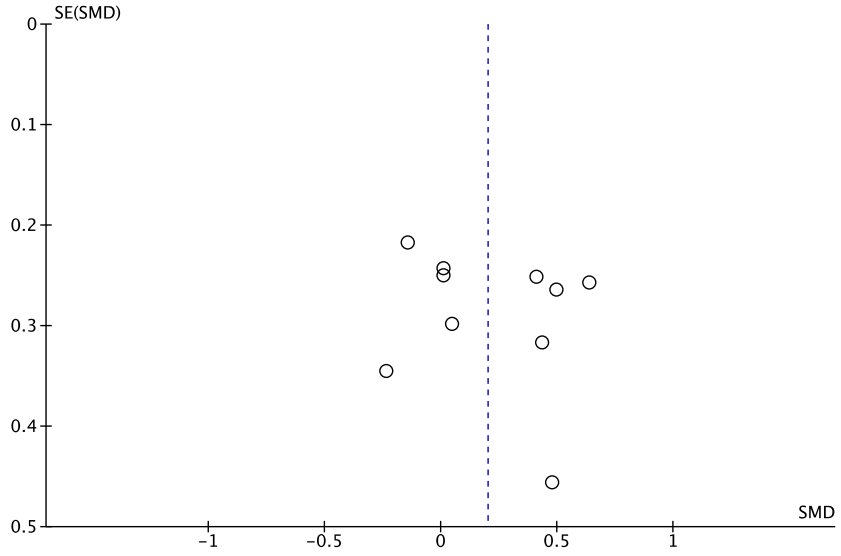



**Figure 3. Funnel plot for random effects meta-analytic model**

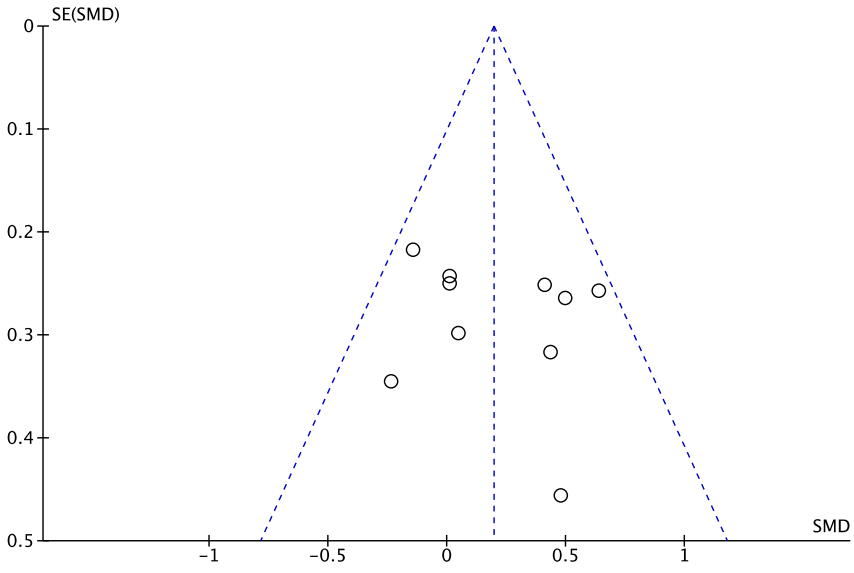



**Figure 4. Funnel plot for fixed effects meta-analytic model**

Two studies were unable to be included. Chu (2014) was unable to be included because its sample included mild, moderate, and severe dementia. While means and standard deviations were

broken out at the time point for those with mild and moderate dementia, the *N* was not reported for these subgroups, and confidence intervals could not be computed. The study found promising effect sizes: for mild dementia, $d = 2.81$, and for moderate dementia, $d = 0.50$. Satoh (2017) was initially included but removed post hoc due to its randomization on the cluster unit and lack of information to be able to be able to analyze differences for the cluster effect. Due to potential cluster effects, this study was omitted from the analysis. The research team, in collaboration with reviewers, concluded that cluster effects could be represented by a correlation among participants in similar groups. Additionally, they recognized that there could be a therapist effect in which a person administering the intervention influenced the outcome.[75] The calculated effect size on the cluster level for the study was not initially promising, $d = -0.14$.

### 2.3.10 Individual studies

For the following outcomes, the minimum requirements to conduct a meta-analysis were not met. Therefore, these outcomes were analyzed qualitatively.

### 2.3.11 Quality of Life

Individual studies reported quality of life. Six studies had the appropriate data to calculate effect sizes, and higher scores were better scores. Cho et al. [49] reported a large effect size (d = 0.86, 95% CI = 0.15, 1.53), as did Kim et al. (2020) [65] (d= 1.08, 95% CI= 0.35, 1.76). Kim et al. (2016) [64] reported a very small effect size (d = 0.12, 95% CI = -0.37, 0.61). Pongan et al.[53] reported a very small effect size, ($d = 0.04$, 95% CI = -0.45, 0.52). Särkämö et al. [61,76] found a

small negative effect, ($d$ = -0.30, 95% CI = -0.81, 0.22), and Park et al. [51] found a large negative effect ($d$ = -1.24, 95% CI = -2.14, -.0.24).

### 2.3.12 Mood

One study had data to calculate effect sizes but did not utilize a validated tool.[56] Two studies had the appropriate data to calculate effect sizes, and for positive mood, high scores were better, and for negative mood, lower scores were better. Cho et al. (2018) found a large effect for increasing positive mood ($d$ = 1.74, 95% CI = 0.92, 2.47) and a large effect for decreasing negative mood ($d$ = -1.01, 95% CI = -1.70, -0.30). Särkämö et al. (2014) found no effect ($d$ = 0.0, CI = -0.51, 0.51).

### 2.3.13 Depression

Six studies had the appropriate data to calculate effect sizes, and depression was measured where lower scores were better scores. Kim et al. (2020)[65] found a medium, bordering on large effect size, $d$ = -0.75 (-1.42, -0.05), and Liu et al.[63] found a small effect size, $d$ = -0.25 (-0.80, 0.31). Giovagnoli et al. (2017) did not find a positive effect, $d$ = 0.77, 95% CI = 0.05, 1.44. In a study the following year, Giovagnoli et al. [69] found a very small positive effect, $d$ = -0.01, 95% CI = -0.60, 0.57. Kim et al (2016) found a very small positive effect, $d$ = -0.05, 95% CI = -0.54, 0.44, and Park et al. did not find positive effects, $d$ = 0.89, 95% CI = -0.07, 1.76.

### 2.3.14 Anxiety

Five studies had the appropriate data to measure effect sizes, and anxiety was measured where lower scores are better scores. Liu et al.[63] found a large positive effect on anxiety, $d$ = -1.71 (-2.33, -1.04). Giovagnoli et al. (2017) did not see positive effects on the State Trait Anxiety Y-1 ($d$ = .08, 95% CI = -0.60, 0.75) or State Trait Anxiety Y-2 ($d$ = 0.50, 95% CI = -0.20, 1.17). Giovagnoli et al. (2018) did not see a positive effect, $d$ = 0.23, 95% CI = -0.36, 0.81, and neither did Pongan et al., $d$ = 0.42, 95% CI = -0.08, 0.90. Park et al. found a small positive effect on anxiety, $d$ = -0.12, CI = -0.99, 0.76.

### 2.3.15 Social Engagement

Two studies had appropriate data to compute effect sizes; social engagement was measured where higher scores were better scores. Giovagnoli et al. (2017) did not find a positive effect ($d$ = -0.91, 95% CI = -1.60, -0.19), and Giovagnoli et al. (2018) also did not find a positive effect ($d$ = -0.69, 95% CI = -1.28, -0.08). See Appendix E for all effect sizes.

## 2.4 Discussion

The results of this meta-analysis showed that the cognitive functioning scores of older adults with probable MCI or dementia who participated in active music were statistically significantly different than those who didn't, in the direction of better cognitive functioning scores, with a small effect size. This analysis demonstrates that active music is the key ingredient to elicit

this effect. Further, all studies utilized either Re-Creating Music by Singing/Playing Instruments or Improvisation. The study team acknowledges there could be a range of contributing factors that lead someone to be diagnosed with MCI, mild, or moderate dementia or have a MMSE score of 13-26. Despite the determining conditions, this preliminary study shows music demonstrated a small but clinically meaningful effect in this diverse population showing similar states of decline. This is impactful for older adults with dementia, their caregivers, their physicians, and those who provide wellness programming – to best support this vulnerable time for cognitive functioning, music programs made for and offered to this population should consider including the active music activities of 1) singing and/or playing pre-composed songs and/or 2) creating music in the moment.

Two areas of emotional well-being that show early promise are quality of life and mood. We examined studies assessing quality of life on the individual level. Of the six studies that assessed quality of life, four showed positive effects, ranging from a very small effect size to a large one ($d$ = 1.08). All interventions utilized Re-Creating Music by Singing/Playing Instruments. Music did not show a positive effect on quality of life compared to physical exercise,[51] and music listening had more of an effect than singing did in a single study.[61] In looking at individual studies that assessed mood, Cho et al.'s large effect on increasing positive moods and decreasing negative moods is encouraging, though Särkämö et al.'s results were negligible. Both music interventions assessing mood utilized Re-Creating Music by Singing/Playing Instruments. The positive effects sizes shown in quality of life and mood make an argument that music, in particular interventions that utilize Re-Creating Music by Singing/Playing Instruments, should be studied in the future as they may provide emotional support to older adults with probable MCI or dementia.

The findings for the effects of active music on depression were promising but uncertain. We analyzed six studies to compute effect sizes. Four studies showed positive effect sizes; they

were very small to medium in strength.[63-65,69] The music interventions included Improvisation or Re-Creating Music by Singing/Playing Instruments; one study additionally included Listening and Movement as smaller components.[65] Park et al.'s large effect sizes suggest that exercise may have a better effect on depression than music, but the sample sizes in each group were small (n=10). There is promise for future studies to consider active music's effects on depression, potentially utilizing the activities of Improvisation and Re-Creating Music by Singing/Playing Instruments.

The results for the effects of active music making and anxiety were unclear. Five studies measured anxiety, and two [51,63] found a positive effects, one small ($d$ = -0.12), one large ($d$ = -1.71). The two studies by Giovagnoli utilized the same music protocol (using Improvisation), so more diverse protocol utilizing active music's activities are needed to understand music's effect on anxiety.

There is potential to better understand how music may affect social engagement. Two studies measuring social engagement reported data for effect sizes, but the same researcher (Giovagnoli) did both studies utilizing a similar protocol that used Improvisation. The effect sizes did not show initial promise for music to support social engagement, but sample sizes were small.

It is critical for future researchers to utilize a standardized reporting system such as Robb's Reporting Guidelines.[16] With music interventions being developed from a range of perspectives (psychologists, occupational therapists, and musicians), activities must be clearly defined for future researchers to understand what musical mechanism may be causing the effect so that future music interventions and programs can utilize these mechanisms to support older adults with probable MCI or dementia. In addition, to better understand the effect of different music activities, there is the potential for subcategories to further define the level of active engagement.

Limitations: Future research will benefit from clear standards for determining MCI, mild, and moderate dementia. We were limited by incomplete data for reporting effect sizes on all studies. When future research reports music interventions in additional detail, researchers will be able to better understand what music activities could support specific outcomes, such as cognitive domains. Additionally, drugs or other therapies could be affecting the outcomes we found.

## 2.5 Conclusion

This systematic review and meta-analysis shows that active music has a small but statistically significant effect on cognitive functioning for older adults with probable MCI or dementia. Individual studies showed potential to have positive effects on mood and quality of life. With an ever-increasing prevalence of dementia around the world, it's critical to identify affordable, safe interventions to support affected older adults. Active music has shown to be an effective intervention; classifying active music within Robb's Reporting Guidelines has created more clarity about the importance of Re-Creating Music by Singing/Playing Instruments and Improvisation. Developing more interventions with these activities and offering these programs widely could potentially provide millions of people with critical support for their cognitive, emotional, and social well-being.

# 3.0 Fidelity of adolescent musicians in the delivery of a digital active music intervention to older adults with Alzheimer's disease and dementia.

## 3.1 Introduction

Currently, over 55 million people worldwide live with dementia, and every year 10 million new people will be diagnosed with dementia.[77] Alzheimer's disease and Alzheimer's disease-related dementias (AD+ADRD) negatively impact older adults' cognitive, [3] emotional, [4] and social well-being.[5] Music is a promising intervention that has shown positive effects in all three areas. [6,12,66,78] Though research suggests music may be a powerful intervention, the delivery of the music intervention bears exploration. Music interventions are often an interactive experience delivered by a musical facilitator. The music facilitator typically has some training in the music intervention, but a gap exists in understanding music facilitators' delivery of the musical components within an intervention. To best determine what music components may be associated with positive effects for those living with AD+ADRD, it is critical to confirm that the musical components are being delivered with consistency across music facilitators. Additionally, with an ever-increasing population living with AD+ADRD, it is important to understand who has the potential to be such music facilitators to expand the study and implementation of music interventions.

Research demonstrates that a range of professionals have facilitated music interventions, including certified music therapists, professional performing musicians, and health professionals. [79,80] Intergenerational research has begun to explore the potential of the power of youth to participate in and facilitate arts interventions. Intergenerational music programs have been shown to benefit older adults' quality of life and social connection[20] and generational perceptions of both

children and adults. [21,22] Programs have been designed for younger children [23,24] and have been facilitated by college students.[25] Though a recent multi-disciplinary arts intervention for adolescents and older adults showed promise in self-awareness and empathy for both generations, [26] there is a paucity of research exploring adolescent musicians' potential to facilitate a music intervention for older adults with AD+ADRD.

A critical first step in exploring the potential of adolescents to deliver a music intervention is to assess fidelity by confirming the young musicians 1) consistently attend the intervention's training and delivery sessions 2) demonstrate preparation of the intervention during the training sessions, and 3) deliver the music components with adherence, which confirms the delivery of each component. [30,81,82] It is important to test and report adolescents' adherence to a consistent music protocol so that future studies can replicate the music intervention, building on the science of understanding what music components may be associated with positive effects for those living with AD+ADRD. Additionally, it is significant to explore the feasibility of recruiting and retaining a sample of adolescent musicians. To clarify future implementation potential, it is crucial to understand if the adolescent musicians are adherent to and would be willing to continue performing the intervention for the rapidly growing population of older adults living with AD+ADRD.

The objective of this study is to assess the fidelity of adolescent musicians in the delivery of Project Unmute, a digital active music intervention for older adults living with AD+ADRD. This research will report on the feasibility of recruiting an adolescent sample, adolescents' attendance of total intervention sessions, preparation of the intervention, adherence to delivering the intervention's music components, and adolescents' willingness to continue performing such a music intervention. Additionally, this study will report on the structure of the training and

mentorship sessions and report the music intervention using the Reporting Guidelines for Music-based Interventions. [16]

## 3.2 Methods

### 3.2.1 Design

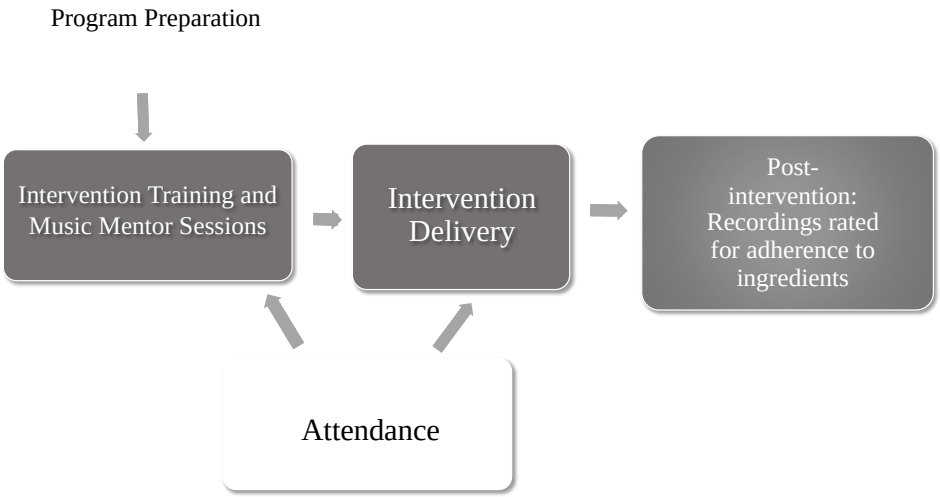



**Figure 5. Study flow**

Fidelity of the adolescents to the music intervention was measured using a single group design. *See Figure 5.*

### 3.2.2 Participants

Adolescent musicians' eligibility required them to be aged 12-18 and have prior musical experience. To ensure representativeness, the research team recruited adolescents that had diversity among age, gender, and number of years playing their instruments. The research team determined that with an increase in representativeness, they could seek diverse samples in larger trials. Demographic characteristics were collected from the adolescents, including age, gender identification, parents' level of education, race/ethnicity, instrument(s) played, and length of musical training.

### 3.2.3 Community Partner

The research team partnered with Dementia360, a community-based program that serves caregivers of older adults living with AD+ADRD in western Pennsylvania. Dementia360 supported recruitment of their families and team members joined each music intervention session.

The research team partnered with an independent college preparatory school in the Northeast that has an enrollment of 700 students. Teachers at the school supported recruiting interested participants.

### 3.2.4 Settings of Data Collection

The research team collected data via Zoom. Music mentor and music intervention sessions were recorded via Zoom for later analysis.

### 3.2.5 Intervention Description

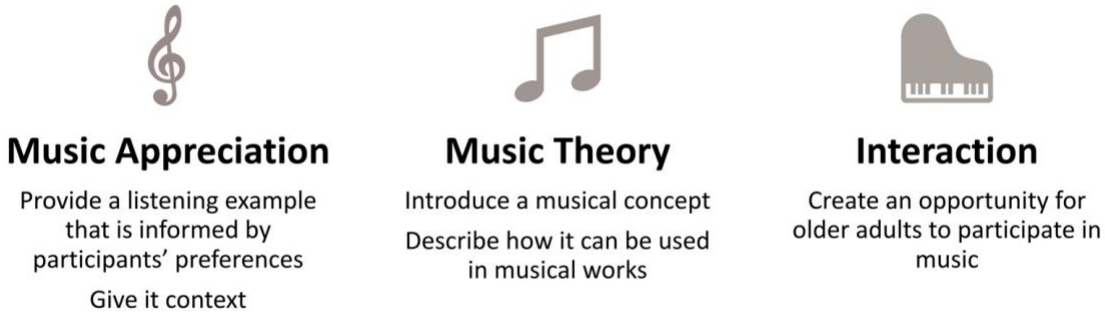



**Figure 6. Activities of Project Unmute**

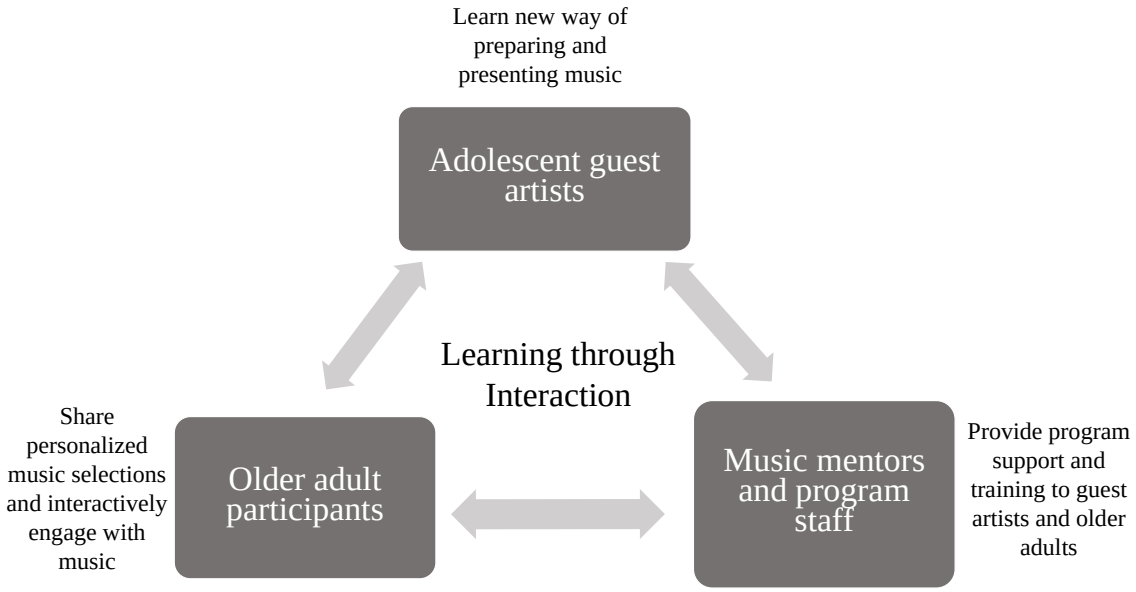



**Figure 7. Intergenerational theoretical model utilizing social constructivism**

The research team developed Project Unmute's intervention protocol with small groups, iterating from stakeholder feedback to improve training and activities.[83,84] The intervention was comprised of three activities, Music Appreciation, Theory, and Interaction. See Figure 6. In each

activity, adolescent musicians were encouraged to scaffold discussion based on individual interaction, such as asking follow-up questions or preparing several interactive activities to maximize engagement.

Project Unmute utilized the framework of Vygotsky's model of Social Constructivism, [85] an educational framework that posits that learning happens during the shared experiences of teacher, students, and other class members. This framework facilitates a non-hierarchical context between the adolescent musicians, older adults living with AD+ADRD, and research and community partner staff. Creating such an "equal footing" allows all members of the group to share ideas and participate in the music. The music selected for the sessions was identified as preferred by the older adult participants; this music was selected due to prior research demonstrating success with the use of preferred music and to encourage attentional responses to familiar music.[80] The construction of a shared environment with preferred music was designed to empower the adolescent musicians to learn to deliver and speak about music in a new way, and emotionally and socially support the older adults living with AD+ADRD. See Figure 7.

The intervention was described using the template provided in the Reporting Guidelines for Music-based Interventions. [16]

### 3.2.6 Measures, Benchmarks, and Data Analysis

#### 3.2.6.1 Attendance

Adolescents' attendance of program sessions was recorded for each session. Their attendance was measured as 0 = no, 1 = yes. The training and intervention session sequence was developed with adolescent musician stakeholders during prior program development.[83]

A benchmark for successful attendance of training and intervention delivery sessions was set at the adolescents' attendance of ≥80% of the intervention sessions.[86] Each adolescent had the potential to attend 10 sessions; if the eight adolescents attended the 10 sessions in the program, there was a possibility of 80 sessions total.

To calculate and report attendance, the research team divided the number of program sessions attended by the total number of program sessions to calculate the percentage of attendance. All sessions were analyzed and drop-out rates were included. See Appendix F for attendance measurement tool.

#### 3.2.6.2 Program preparation

Adolescents were supported by Music Mentors, two research team members who were trained in the intervention, mentoring adolescents, and assessing program preparation. Adolescents' preparation of the intervention was rated per session and was completed by the Music Mentor leading the session. Adolescents' preparation was measured on a scale from 0-2; 0 = no plan has been made, 1 = a plan has been made but the participant does not have ideas for all three ingredients, 2 = a plan has been made and the participant has ideas for all three ingredients. Additionally, Music Mentors recorded how long the adolescents prepared for each session and the length of each session. The program preparation questions were developed with Music Mentor stakeholders during prior program development.[83]

Compliance with program preparation was considered successful if ≥ 80% of participants demonstrated preparation during their Music Mentor sessions.[86] To calculate program preparation, the research team first dichotomized the answers. Scores of 1 and 2 were combined to be a 1, which represents some level of program preparation, or "yes." 0 remained the score for those who had no program preparation, or "no." To ensure proper training, Music Mentors assessed preparation for

the intervention after the first Music Mentor session. If participants did not demonstrate preparation, they were retrained and an additional session was added, and its rating was used in place of the first.

To calculate program preparation, the research team computed the number of 1/yes scores divided by the total number of sessions to calculate the percentage of adherence. Only completed sessions were analyzed to best show the effort of the adolescent musicians, as the attendance measure reported if they did not attend the session. See Appendix G for program preparation measurement tool.

#### 3.2.6.3 Adherence to delivery of intervention

Adolescents' delivery of the intervention was scored based on the intervention's ingredient. Intervention ingredient delivery was measured utilizing the Fidelity Review Form. Adherence, which captured if the adolescents delivered each of the ingredients, was measured as 0= no, 1=yes. Competence, which captured how well adolescents delivered each of the ingredient, was measured on a scale from 0-2; 0=inadequate, 1=adequate, 2=exemplar. The Fidelity Review Form was developed over iterations of program development with an experienced music therapist and adolescent musicians in discussions about ingredients and delivery.[83,84] The Fidelity Review Form was pilot tested with two members of the research team who were trained in the intervention and in the use of the Fidelity Review form. The research team set a benchmark of 90% agreement about the rating of two prior sessions' ingredient delivery to confirm reliability of training. All discrepancies in rating were discussed. Each adolescent participant was rated on one randomly selected session.

Adherence to intervention ingredient delivery was considered successful if participants showed a rate of ≥80% adherence to the intervention's ingredients while delivering the protocol.[86] Each ingredient was considered separately; scores were not totaled per adolescent.

To calculate adherence to delivering the intervention, the research team calculated the adherence rates for each adolescent musician within SPSS, v. 28.[87] Scores of 1 (indicating the participant demonstrated the ingredient) were divided by the total number of ingredients to calculate the percentage of adherence. Only completed sessions were analyzed to best show the effort of the adolescent musicians, as the attendance measure reported if they did not attend the session. See Appendix H for fidelity review measurement tool.

### 3.2.7 Sample size justification

The sample size proposed was eight adolescent musicians, who were measured for attendance to 10 required program sessions (n = 80), compliance to four program preparation in Music Mentor sessions (n = 32), and adherence to three active ingredients during one randomly selected session (n = 24). The sample size was guided by previous intergenerational music programs, which were developed with young musicians and incorporate similar structures of training, rehearsals, and performances.[88-91] The development phase of the intervention further guided the chosen sample size; four adolescents had 100% attendance of the required program sessions, and resources were assessed to understand the feasibility of recruiting and keeping adolescents engaged across the program. [83] In considering the 80 total sessions of the intervention, the research team used a binomial test to calculate a confidence interval of eight adolescents having a 20% chance of missing at least one session (95% CI = 0.70, 0.88), suggesting that 70%-88% of the adolescent sample would attend all sessions.

## 3.3 Results

### 3.3.1 Participants

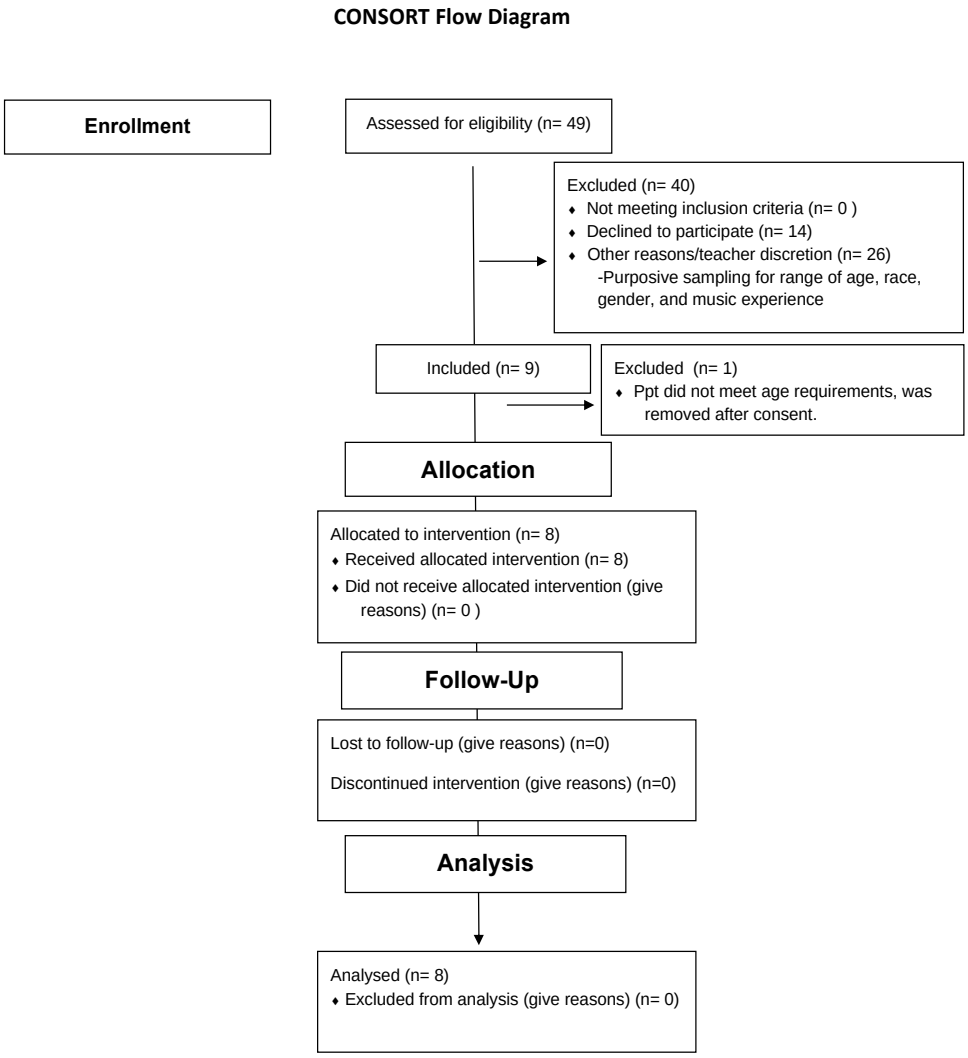



**Figure 8. CONSORT flow diagram**

The research team screened 49 adolescent musicians for participation. Fourteen declined to participate, and 26 were withdrawn by their music teachers to assist the research team in

purposively sampling for age, race, gender, and music experience. One participant was removed after the consent process because they did not meet the age requirement. See Figure 8.

Eight adolescent musicians participated in the study, and all eight stayed in the study until completion. The participants ranged from 14 to 18 years old. All were cisgender and 62.5% identified as male. The participants were 25% white, 12.5% Hispanic and white, 12.5% Asian and white, 25% Asian, and 25% African American. 50% of participants' parents had received a Master's degree as their highest form of education, 25% had received a Bachelor's degree, and 25% had received a PhD or MD. They had a range of instruments they considered their current primary instrument, including harp, cello, piano, saxophone, violin, bass, French horn, and clarinet. 62.5% of participants had 10 or more years of musical training, and 37.5% of participants had between five and nine years of musical training. The recruiting and retention of a diverse sample demonstrated feasibility. *See Table 1.*

**Table 1. Adolescent demographics**

| Adolescent Participants (n=8) | |
|---|---|
| Variables | Frequency (%) |
| **Age** | |
| o 14 | 2 (25%) |
| o 15 | 2 (25%) |
| o 17 | 3 (37.5%) |
| o 18 | 1 (12.5%) |
| **Gender** | |
| o Male | 5 (62.5%) |
| o Female | 3 (37.5%) |
| **Race** | |
| o White | 2 (25%) |
| o Hispanic/White | 1 (12.5%) |
| o Asian/White | 1 (12.5%) |
| o Asian | 2 (25%) |
| o African American | 2 (25%) |
| **Parents' education** | |
| o Bachelor's | 2 (25%) |
| o Master's | 4 (50%) |
| o PhD or MD | 2 (25%) |
| **Instrument** | |
| o Harp | 1 (12.5%) |
| o Cello | 1 (12.5%) |
| o Piano/Saxophone | 1 (12.5%) |
| o Violin | 2 (25%) |
| o Bass | 1 (12.5%) |
| o French horn | 1 (12.5%) |
| o Clarinet | 1 (12.5%) |
| **Length of Musical Training** | |
| o 10 years or more | 5 (62.5%) |
| o 5-9 years | 3 (37.5%) |

### 3.3.2 Intervention Reporting

The intervention's delivery is described using Reporting Guidelines for Music-based Interventions.[16] *See Appendix I.*

### 3.3.3 Attendance

Program sessions were scheduled by the PI and Music Mentors over Zoom, taking place from January 2022 through May 2022. All eight participants attended each of their 10 intervention sessions, yielding 100% attendance. This exceeded the research team's benchmark of adolescents' attendance of ≥80% of the intervention sessions.

### 3.3.4 Program Preparation

Participants earned a 1/yes for 32 out of the 32 available Music Mentor sessions, or 100%. This exceeded the research team's benchmark of ≥ 80% of participants demonstrating preparation. Additionally, 91% of the sessions were scored a 2, in which participants came with ideas for all three intervention ingredients. The adolescents reported preparing from 15 to 210 minutes for Music Mentor sessions, and sessions lasted between 11 and 60 minutes.

### 3.3.5 Fidelity

Two raters, who also served as the Music Mentors, were trained in the music intervention and fidelity review guide. They independently rated two intervention sessions of a Project Unmute session from a previous young artist and recorded 100% agreement about the ratings of delivery and description of activities. This exceeded the research team's benchmark of 90% agreement.

Each rater independently rated the randomly selected session for each participant. The raters had 100% agreement on their ratings for all eight sessions. Each participant scored 100% adherence to each of the three ingredients of their scored session. Out of 24 possible administered

ingredients, all 24 were delivered with adherence. This exceeded the research team's benchmark of the participants demonstrating a rate of ≥80% adherence. Additionally, the raters scored for exceptional competence, which demonstrates an exemplar performance of the intervention. Out of 24 possible administered ingredients, all 24 were delivered with exceptional competence. The research team also recorded a description of how participants performed different intervention activities. *See Appendix J.*

## 3.4 Discussion

This research study explored the potential of adolescents to reliably deliver a digital active music intervention for older adults living with AD+ADRD. This study demonstrated that adolescents took ownership of the music intervention and delivered it consistently. This suggests that adolescent musicians may be potent future facilitators of music programming, potentially supporting the cognitive, emotional, and social well-being for older adults living with AD+ADRD. There are additional lessons learned from this study worth highlighting: 1) the structure of the intervention's training and delivery, 2) the intervention itself being designed to promote active engagement, and 3) the feasibility of recruiting adolescents and the willingness of the adolescent population to continue performing the music intervention.

One of the innovations was the program's structure. The training structure and mentorship schedule allowed adolescent participants to both prepare and debrief with a musician with expertise in the intervention, which the research team posits is critical to their preparation to be successful. This builds on the understanding that it is crucial to properly train younger generations in working with older adults living with AD+ADRD.[92-94] There is an opportunity to further test

the dosage of mentorship that would be needed for adolescent participants to continue administering the music intervention beyond the first three performances and if adolescents would be able to provide peer mentorship to other adolescents learning to facilitate the music intervention.

Additionally, performing the intervention via Zoom was successful in negotiating one of the key barriers of working with adolescents – their busy academic and extracurricular schedules. It also helped to facilitate caregivers of those living with AD+ADRD during a vulnerable time, when moving their loved one to a shared space, regardless of the pandemic, would have been prohibitive. Music Mentors incorporated technology training into their sessions to encourage adolescent performers to utilize optimal sound settings for sessions; for example, the "Original Sound" setting in the Zoom interface benefited instrumental performance audio. Simple external microphones may add additional sound benefit, as may speakers or headphones for the older adult participants.

The intervention itself builds on music intervention research suggesting that active music can elicit positive outcomes in older adults living with AD+ADRD.[80] Utilizing familiar music and interactive opportunities, this program is designed to promote engagement between the generations. This type of programming would benefit from future research measuring the mechanism of music engagement, a measurement of participation, in both generations, including potential relationships between music engagement and positive outcomes.

These findings suggest that adolescents can successfully facilitate a digital active music intervention for an older generation and can adhere to the delivery of the musical components. Previous intergenerational arts programming has utilized college students as facilitators[25] and paired younger children with older adults in programs facilitated by others.[23,24] A recent arts-based intervention that paired adolescent and older adults with dementia showed the potential to support

empathy and self-awareness for both generations, but was facilitated by others.[26] Project Unmute was designed specifically with adolescents as the music facilitators. These promising initial findings suggest that it is feasible to recruit and retain a diverse sample of adolescents. Additionally, adolescents can successfully deliver and would be willing to continue performing music interventions in future studies and community programs, providing a large, scalable generation of facilitators to support older adults living with AD+ADRD.

### 3.4.1 Limitations

While this study demonstrates several benefits, limitations do exist. We recruited a small sample of eight adolescent musicians connected to one community-based organization, limiting the generalizability of the findings. The sample was also not randomly selected. While the study team worked to recruit a diversified sample, future studies will benefit from understanding the diversity of adolescents who would be successful at delivering such a music intervention.

This research demonstrates that adolescent musicians have high potential to be adherent facilitators of digital active music interventions for older adults living with AD+ADRD. Further, it shows that the adolescents were successful in their attendance, agreeable to the training and preparation of the music intervention and were willing to continue performing beyond the three performances for the research study. With the expected prevalence of AD+ADRD growing exponentially in future years, these young musicians could be a dependable, scalable support for the cognitive, emotional, and social well-being of millions of vulnerable older adults.

## 3.5 Lessons Learned

### 3.5.1 Structure of training and mentorship.

We suggest offering two one-hour training sessions: one to introduce the music intervention and one to introduce adolescents to performing for older adults with AD+ADRD. Additionally, the Music Mentor sessions prior to the first three performances provided a valuable feedback mechanism. Future implementers may consider offering flexibility in the Music Mentor sessions' schedules, such as offering two 30-minute sessions instead of one 60-minute session. Adolescents were adherent to preparing for these training and Music Mentor sessions, demonstrating that such a structure is acceptable and is a critical support to the adolescent musicians in preparing the intervention.

### 3.5.2 Intervention content.

The adolescents were successful in planning 30-minute music programs that incorporated Music Appreciation, Theory, and Interaction. In the future, the research team recommends updating the component of "Theory" to "Musical Concept" as a more approachable term for the adolescent musicians. The adolescents demonstrated creativity in delivering the ingredients, which suggests that this intervention is flexible across a range of young musicians' interpretations. See Appendix J.

### 3.5.3 Method of delivery.

Offering the music intervention via Zoom was a key facilitator to scheduling busy adolescents and the caregivers and older adults with AD+ADRD. The delivery mode allowed for successful musical performances and interaction between the generations. The success of the use of Zoom offers the powerful potential to utilize this medium in future implementation, eliminating barriers for the two generations to connect, and suggesting powerful scalability for the accessibility of future adolescent musicians to serve the millions of older adults living with AD + ADRD.

# 4.0 A Qualitative Study of Adolescents' Characteristics and Experiences Delivering a Digital Active Music Intervention to Older Adults with Alzheimer's and Dementia

## 4.1 Introduction

Worldwide, 55 million people are living with dementia. By 2050, that number is expected to rise to 139 million people. [77] Alzheimer's disease and Alzheimer's disease-related dementias (AD+ADRD) have a devastating impact on the lives of older adults, including negatively impacting their cognitive, [3] emotional, [4] and social well-being. [5]

Music is a non-pharmacological intervention that has demonstrated positive effects for older adults living with AD+ADRD, including suggesting support for their cognitive function, emotional well-being, and social connection.[6,12,66,78] A recent systematic review[80] specified the effects of actively participating in music, finding music participation supported cognitive function for older adults with AD+ADRD. As the research around music interventions gains clarity, a potent area for investigation are the music facilitators, who deliver the music content.

Evidence has shown a diversity of experience within facilitators of music interventions, including the of music therapists, performers, and health professionals.[79,80] Understanding who can facilitate a music intervention is crucial to translating music interventions into the community to serve the rapidly growing population of older adults living with AD+ADRD.

### 4.1.1 Intergenerational programs

Intergenerational programs, activities which serve multiple generations, have been shown to promote cross-generational comfort[22] and positively influence children's perception of the elderly.[21] Additionally, research has shown participating in intergenerational programming has positively influenced older adults' perceived quality of life and social connection.[20] Intergenerational music programs have utilized a variety of designs, ranging from pairing preschool children with older adults living AD+ADRD,[95] pairing pre-adolescents with both older adults and older adults living with AD+ADRD,[22] and pairing college students with both older adults and those living with AD+ADRD.[88,96] A gap exists to better understand how adolescents and older adults with AD+ADRD interact.

Researchers have begun examining if the younger generation can facilitate the arts-based intervention to the older generation.[97] Adolescents are a promising population to explore as potential music intervention facilitators, as they have been shown to benefit from music in terms of their emotional well-being,[27] self-esteem,[28] and identity.[98] There is a gap in the research exploring the characteristics and experiences of adolescents who deliver a music intervention to older adults living with AD+ADRD. It's important to understand the adolescents' characteristics to clarify the qualities of future adolescent musicians who may be facilitators of this program. This could both enable future researchers to identify young participants and empower those running community programming to understand the scalability of the program to reach the millions of older adults living with AD+ADRD. Additionally, it's imperative to understand the experiences of the adolescents in delivering such a program. This understanding would help researchers iteratively

improve the program and training and elucidate potential outcomes that could be supporting adolescents in a vulnerable time in their development.

Our aim was to assess the characteristics and experiences of adolescent musicians regarding the delivery of a digital active music program to older adults with AD+ADRD. To do so, we completed in-depth interviews with the adolescent musicians and conducted conventional content analysis to examine their characteristics and experiences with the training and implementation of the digital music program. The research team utilized the Standards for Reporting Qualitative Research (SRQR), a 21-item checklist that defines standards for reporting on qualitative research.[99]

## 4.2 Methods

### 4.2.1 Program and theory

Project Unmute is a digital active music intervention that utilizes the learning theory of Social Constructivism to promote shared music learning, discussion, and participation between the adolescent musicians, the older adults and their caregivers, and the research team and community partner staff. After being developed iteratively with stakeholders,[83,84,100] the training structure and ingredients were finalized. The training structure includes training in the music intervention, training in communicating with older adults living with AD+ADRD, and training from Music Mentors with whom adolescents practiced their individual music programs. Then, adolescent musicians performed three 30-minute music programs for small groups of older adults living with AD+ADRD and their caregivers.

### 4.2.2 Qualitative approach and research paradigm

This qualitative study used a descriptive phenomenological methodology[101] to explore the characteristics and perceptions of the adolescents providing the music program. This methodology was chosen to promote in-depth insights to real-world situations.[102] This study utilized a constructivist paradigm, recognizing that there are multiple interpretations of reality, with a goal of understanding how the adolescent musicians construct the reality of their experiences as musicians and in the training and delivery of a digital active music program to older adults living with AD+ADRD.[102]

### 4.2.3 Researcher characteristics and reflexivity

The PI (JD) is a graduate student researcher in Rehabilitation Science at the University of Pittsburgh with a background as a classical musician. She has designed music programs for older adults with AD+ADRD and music programs for adolescents. The PI consented the adolescent participants, conducted the interviews, and served as a Music Mentor. The PI's previous positive experiences in dementia music programming could have influenced the adolescents in that she positively presented the opportunity to perform in such a setting. The adolescents could have reacted to her positive attitude by mirroring it, rather than expressing their own doubts, concerns, or questions. It was important for her to educate the adolescent musicians on their role in the research to encourage honest and constructive feedback, mitigating the potential for the adolescent musicians to answer questions with purely positive responses.

### 4.2.4 Context

The study took place using the digital platform of Zoom. In response to the COVID-19 pandemic, many community programs serving older adults switched to virtual platforms to continue providing program content in a safe manner. The research team partnered with Dementia360, a western-Pennsylvania-based community organization serving older adults living with AD+ADRD and their caregivers. Dementia360 provided an existing Zoom link that had been utilized by their clients to access programming throughout the pandemic. Understanding how to offer digital music programs is critical; many older adults living with AD+ADRD run the risk of becoming isolated geographically and/or losing the ability to drive. If meaningful programming is accessible online, these older adults can continue to engage in stimulating programming. The research team supported the digital programming by offering technical training to the adolescent musicians to ensure they had the highest possible quality of performance sound and utilized the unique features of Zoom's platform to share the musical activities.

### 4.2.5 Sampling strategy

We used criterion sampling to ensure we captured the experiences of adolescent musicians who had the shared experience of delivering the phenomenon under study, the digital, intergenerational music program.[103] Though the most prominent criterion is that they have had the shared experience of delivering the music program, we sought adolescents that varied in their characteristics and individual music backgrounds.[103] The research team looked for diversity among adolescents' age, race, gender, and number of years playing their instrument.

The research team planned to enroll eight adolescent musicians, guided by the framework of typical sample sizes for phenomenological studies.[103,104] This sample size was also guided by the rigorous assessment offered by Guest et al., in which the research team found that six to seven interviews captured the majority of themes in a homogenous sample.[105]

### 4.2.6 Ethical issues pertaining to human subjects

This study received Institutional Review Board (IRB) approval. Consent from guardians and assent from adolescent musicians was obtained.

### 4.2.7 Data collection methods

Data was collected through in-depth interviews to provide detailed descriptions of adolescent musicians' characteristics and experiences.[101] Interviews have been suggested as the appropriate method of data collection for a phenomenological design[104] due to their ability to closely capture the individual experience. Interviews were semi-structured, to leave room for probing questions to stay close to the lived experience.[104] The interviews were estimated to take 60 minutes each, one prior to the study beginning and one after the research study was complete.

### 4.2.8 Data collection instruments and technologies

A description of the interview guide is included. Each session was recorded on Zoom. See Appendix K.

### 4.2.9 Units of study

The units under study were adolescent musicians' characteristics, their potential learning, and their reflections on the training and delivery of the intervention. [104] Each of the eight adolescent musicians were offered two in-depth interviews to reflect on each of these areas.

### 4.2.10 Data processing

The research team utilized Zoom's transcription services, but additionally listened to each interview to clean the formatting and correct any automated errors from the transcription. During this process, they additionally de-identified any recognizable information from the transcripts. Transcripts were uploaded to NVivo, a qualitative data analysis software.[106]

### 4.2.11 Data analysis

Because the aim was to describe a phenomenon and there was limited literature on the experience of adolescents delivering a digital active music interventions, the research team followed a conventional content analysis approach.[107] This analytic approach helped researchers identify categories and patterns in transcribed data in a deductive manner.[107] The research team utilized conventional content analysis over phenomenological and thematic analysis because of the lack of description that currently exists about the lived experience of adolescents delivering an intergenerational music program.[108] Conventional content analysis aligned with the research team's goal of developing a concept of the characteristics and experiences of adolescents when delivering a music program.[107]

The research team used an iterative process to code the interviews. They listened to the digital recordings of the interview and identified coded keywords. Then, the codes were evaluated and categorized. Themes were selected based on combining and grouping codes. The research team determined if larger categories were needed to create a hierarchy among related themes. The research team established consensus by meeting to discuss coding structure and having two researchers (JD and KR) independently code 20% of the data. These researchers met and discussed coding until a consensus was reached.

### 4.2.12 Techniques to enhance trustworthiness

For credibility, the research team shared thematic findings from the analysis with the adolescent musicians for confirmation. For transferability, the researchers provided rich descriptions of the characteristics of the adolescent musicians and their experiences with the different aspects of the intergenerational music program. For dependability and confirmability, the research team kept an audit trail, or documentation of the research steps taken from the start of the research project to the development and reporting of the findings.[104]

## 4.3 Results

The research team worked with music teachers at an independent college preparatory school in the Northeast to recruit adolescent musicians. Together, they screened 49 adolescent musicians. 14 musicians identified to their teachers that they did not want to participate. The music teachers screened 26 additional adolescent musicians to aid in purposeful sampling between age,

race, gender, and music experience. One adolescent completed the consent process but was removed after, as they did not meet the age requirement. Eight adolescents enrolled in the study and participated until its completion. In addition, the research team collected observations important to the intervention's iteration and reported them in a Lessons Learned table. See Appendix L.

### 4.3.1 Characteristics

The research team asked adolescent musicians about their characteristics prior to performing the intervention. Four major themes emerged:

**Theme 1. Relationship to music.**

Adolescents described a positive previous relationship to music. They spoke about their "*strong connection to music*" (101), saying "*I've never found music gets boring*" (103) and "*I've always loved music, since a very young age."* (105) They also explored how music functions in their lives, including as a means of expression and of escape from their daily lives:

> *"For me the harp it's like an escape or I always find myself, if I have like a ton of homework, I'll put it down and walk in and play the harp and come back, it's kind of like my own personal little thing that I have." (108)*

The adolescent musicians also discussed how their previous and current musical training created internal motivation – they were aware of what skills they wanted to acquire to be better

musicians, such as learning to improvise or exploring different genres of music beyond classical. They also described their initiative in their own music training:

> *"I mean, whenever I hear a piece of beautiful music, I just want to play it and then kind of all the tunes from all different songs just to, like, know playing out that I can play it out, it gives me a sense of, like, self-achievement." (105)*

**Theme 2. Creatives.**

The adolescent musicians identified with being creative, participating in creative activities, and the importance of creativity. One adolescent described doing sculpture and journaling, another adolescent enjoyed design and collage, and a third did crocheting and knitting in their free time. Multiple adolescent musicians discussed that they found being creative to be an important skill:

> *"….in English and even math or other subjects being creative, I think, is really helpful and can really motivate you to think about things differently." (104)*

While many adolescents discussed creativity outside of music, one discussed how they use it in their performance, *"being creative with like how I take a piece and kind of put my own spin on it and make it my own."* Another described how it helped shaped their practice of music, *"It's*

*like the same with practice, if you're not really creative about it, it becomes sort of dull, you have to find ways to make it interesting for yourself while also learning."* (107)

**Theme 3. Developing responsibility and maturity.**

Adolescent musicians discussed having strong support systems in their lives that offer them the opportunity to grow more responsible. Most of the adolescents commented on their school's role in supporting their growing maturity:

> *"With boarding school that was the biggest like, switch from being cared for to caring for yourself. I guess, when it first started, I was like skipping meals and on my phone a little bit too much. But yeah, gradually it did come more naturally but I definitely had to, like, switch a gear in my brain to be able to do that." (107)*

Adolescent musicians discussed the support from their families for introducing them to music and providing the resources to participate. One adolescent had no interest in music until their mother began playing classical music in the car and signed them up for violin. (103) Several watched their older brothers and sisters play instruments: *"I'd watch through the little windows, him playing the piano, and I always wanted to try myself because if he's doing it, I can I do it."* (108)

**Theme 4. Value others.**

The adolescents were emphatic that they related keenly to others, particularly those who are different than them: "*If someone is different from me, then obviously I won't have the same experiences as them, so being able to learn from those experiences and kind of take from those thoughts of other people, like, kind of allows me to grow as a person myself."* (109)

The adolescent musicians also cited that connecting with others was a motivating factor in participating in the research project:

> *"Well, I was really excited about, like, the prospect of using my French Horn in a different way. Because I've never really, like, played music, for reasons other than just, like, my own enjoyment or orchestra or something like that, so I think it's exciting to try to see where else it could take me in the future, and now." (102)*

### 4.3.2 Experiences

After each adolescent musician completed their delivery of the intervention, they did an interview with a research team member to discuss their experiences. Three major themes emerged:

**Theme 1. New opportunity in music.**

The adolescent musicians explained what new music opportunities the program offered them outside of their existing musical training:

*"I feel like I learned a lot about what I, like, think about when I listen to music and a lot of times it's not like, the dynamics or anything, and it's just, like, how I feel when I hear the song. I've been listening to the songs that I've played, like, over and over again since then." (102)*

*Don't have to play perfectly.*

The adolescent musicians describe their nerves during traditional performances and made sense of how the experience affected their perfectionism toward playing. One adolescent musician said they learned to view it as *"I'm just playing for playing right now,"* (101) and let go of a perfectionistic mind-set. Another said that while they were self-critical of their own performances, they were aware that there was not judgement from the audience. Several adolescents cited that performing in Project Unmute helped ease their musical performance anxiety:

*"…. every single time I have a recital of something like the stage fright and the anxiety, it always circles back right before I'm performing. But after my first performance, like for my second, third performance, I didn't have any stage fright at all or wasn't scared at all." (103)*

*Learning music's impact.*

Adolescent musicians recounted the importance of seeing music creating an effect on their audience, recalling times that older adults moved to the music, showed excitement, and smiled:

*"It's just the power of music in general. Like, the way how music can cheer people up." (105)*

*Improvise.*

The adolescent musicians explored improvisation during delivering the intervention. Multiple adolescents talked about their prior need to use a script during presentations or play only from sheet music. One said by their final performance they only needed an outline of four words to guide them through their presentation, and another felt comfortable switching the order of activities they planned. Often, these improvisations would come as they discussed the music with the older adults:

*"…. a lot of the time I was just pulling, like I would play the piece itself, and then, when I actually, like, was talking through the music presentation I would just pull random pieces from the top of my head and it would be, like, yeah, I would have either, like, not have them memorized or not played it for a couple years or just learned it by ear or something like that." (107)*

**Theme 2. Human Connection**

Many of the adolescent musicians described the connection they felt to the older adults living with AD+ADRD while they performed the intervention, saying they *"had a lot of fun hanging out with them"* (101) and *"it definitely felt pretty comfortable, like, lots of people were*

*involved. Like you could see that they were engaged in whatever I was saying, which was nice."* (102). The adolescents spoke about different aspects of the musical performance where they felt most connected with the older adults:

> *"I guess I really enjoyed the interactions I had with them and I guess just being able to break through some of that just to really get to see them where they are. I think, like the engagement parts of the performances were really helpful with that, kind of getting them involved with the creation of music. It was mostly those parts that I thought I could really talk to them." (104)*

*Creating new awareness of Alzheimer's and dementia.*

In addition, the adolescent musicians described how the experience broke preconceived notions or built new awareness of people living with AD+ADRD. Adolescents who had family members living with dementia mentioned applying some of the communication skills they learned in Project Unmute with their family member: *"...giving them time and space to kind of process was really helpful. [It's] something I'm trying with my grandmother now, so that's been really good."* (104) Many mentioned having an idea that the older adults would not be responsive to them and being surprised at the level of interaction:

> *"I definitely feel more comfortable, just like interacting and like talking with older adults with Alzheimer's. I feel like being able to interact with them*

*and talk about certain things that, you know, I'm interested in, and they're interested in, too, I thought that was super cool and super interesting." (109)*

**Theme 3. Structure led to stress-free environment.**

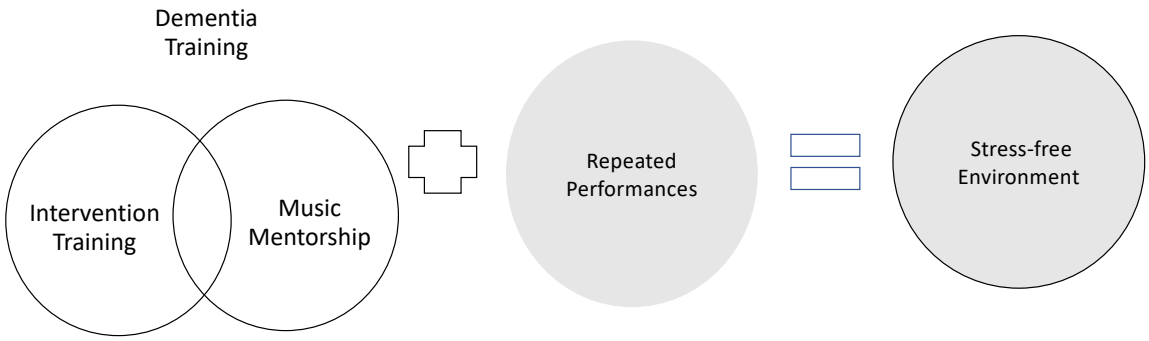



**Figure 9. Structure of Unmute intervention sequence**

The adolescent musicians discussed the effects of the structure of the program, including the training and the ability to perform the program repeatedly. In Figure 9, researchers have created a visual representation of the four main components of the intervention, including the intervention training, the dementia training, the Music Mentor sessions, and the repeated performances. Adolescent musicians attributed this combination of factors to creating a stress-free environment:

*"...In terms of, like, the amount of hours I had to put in, it was, like, very few in a good way in terms of it wasn't stressful and it wasn't some added stress in my life, it was literally just like this very fun experience that I'm getting to be a part of." (101)*

## 4.4 Discussion

This study presents a digital active music intervention delivered by adolescent musicians to older adults living with AD+ADRD. In this study, we trained the adolescent musicians in the intervention and they performed three 30-minute music interventions for the older adults. Our results showed that participating in an interactive, intergenerational music program supported adolescents with their performance anxiety, enabled them to think on their feet, and fostered new understandings and connections with an older generation.

### 4.4.1 New opportunity in music may provide mental health benefits to adolescents

Adolescent musicians enumerated the new opportunities in music they experienced, many of which centered on their own well-being. This study adds to the current evidence base in identifying mental health benefits for adolescents participating in an intergenerational music program. Prior intergenerational research has explored college students' perceived effects of heightened performance experience[91] and positive perceptions of facilitating music sessions. [88] Our study initiates an understanding of the adolescent experience, as these musicians reported the program does not add stress to their lives and suggest it aids in performance anxiety and their ability to improvise both musically and verbally.

This clarifies three important points: 1) For the adolescents to feel at ease delivering the protocol, it is critical to continue offering the multi-pronged intervention training structure to support them. This builds on previous evidence elucidating best practices in intergenerational programming, which suggests the importance of facilitator training and structure. [109,110] However, researchers should consider that these adolescent musicians indicated strong support systems in

their school and family lives, which may provide additional confidence in delivering the program. To better understand the breadth of adolescent who can deliver the intervention without stress, future research can explore if adolescents with less supports at school and home may need additional resources. 2) Adolescent musicians asserted that participating in this program reduced their musical performance anxiety. This is important, because research has shown that musical training can increase musical performance anxiety, which in turn has an effect on anxiety, negative emotions, and belief in self-efficacy.[111] Future research could study the specific outcome of performance anxiety in adolescents to understand if this type of program delivery could benefit their perceptions of performance. 3) The adolescent musicians described the different ways they were able to improvise during their performances, both in terms of playing music and in verbally delivering the presentation. It is important to understand if the adolescent musicians' ability to think on their feet may be supporting their resilience. Previous studies have shown participation in music to increase resilience in children, which can be critical in supporting long-term mental health.[112]

### 4.4.2 Human connection and generational awareness

This study is consistent with previous studies that elucidate the benefits of generational awareness on children who participate in intergenerational programming. [20-22] This adds to the evidence in creating a unique understanding of the experiences of adolescents who have facilitated the intergenerational program. The adolescent musicians reported that they felt increased human connection and developed a new awareness of people different than them. Additionally, they described the importance of witnessing music's impact on the older generation as they performed for them.

This suggests that future research could explore the outcomes of empathy and prosocial behaviors in adolescents who facilitate similar intergenerational protocols. This builds on previous research that suggest music training can increase levels of empathy. [113] These adolescents did self-identify as people who "valued others" in their pre-intervention interviews; those recruiting future adolescents could test if this characteristic is needed to produce a change in empathy.

### 4.4.3 Rigor

For credibility, the research team did member-checking to confirm the acceptability of the themes with 62.5% of the adolescent musicians. The adolescent musicians agreed that all of the themes were representative of their characteristics and experiences. During a member-check session with one of the adolescent musicians, they reported that after Unmute they arranged to study music and research over the summer. They explained they had a new interest for how music can be used and how it can reach people. They said the experience made them feel that "music is for the world."

For transferability, this study provided rich descriptions of the adolescent musicians and their experiences delivering the music intervention. For dependability and confirmability, the research team described the steps taken during the project, and records of the research path were kept throughout the study via an audit trail. For reflexivity, the PI (JD) utilized the other members of the study team to examine her own positive assumptions and preconceptions of music due to her prior classical music training. She deliberated research processes with co-investigators to ensure best practices were utilized.

### 4.4.4 Limitations

While this study highlights multiple benefits, there are limitations. The research team utilized one community partner who served older adults with AD+ADRD and their caregivers, and the study had a small sample of eight adolescent musicians from the same school, which limits the generalizability of the results. While the research team worked to provide rich descriptions of the sample and recruited with diversity of age, gender, race/ethnicity, and experience in mind, research will benefit from understanding the characteristics and experiences of a larger, more diverse sample of adolescents.

## 4.5 Conclusion

This research demonstrates that participating in delivering a digital active music intervention may benefit adolescent musicians in multiple ways, including supporting their mental health and promoting empathy for an older generation. As mental health concerns grow for adolescents, participating in such a program may provide critical supports during this vulnerable time in their development. Further, the adolescents described the importance of connecting with the older generation. With cases of AD+ADRD rapidly increasing, these young musicians may be able to provide a scalable, empathetic support for millions of older adults.

# 5.0 Discussion

It is crucial to develop interventions to support older adults living with Alzheimer's disease and Alzheimer's disease-related dementias (AD+ADRD). With a worldwide estimate of 139 million people expected to be living with AD+ADRD in 2050,[77] we need to understand what interventions may be able to support the lives of these millions of older adults. Music has shown powerful potential to support critical areas of decline during AD+ADRD.[3-5] However, this promising evidence reports little information about the specific music activities utilized to produce these effects.[16] It is critical to understand music's key activities to best understand if and why a music intervention has the potential to support crucial outcomes.[29] Without such understanding, millions of older adults living with AD+ADRD may miss out on participating in an enjoyable, safe modality that could support their health and well-being during a vulnerable time in their lives.

It is also important to understand the delivery of the music intervention. Music interventions are delivered by music facilitators, who often vary in their experience and employ a range of approaches to delivering the activities. This clouds the understanding of the intervention's effect.[29] Previous evidence has shown a diversity in those who have facilitated music interventions,[79,80] and researchers have begun exploring if young adults can deliver arts interventions.[97] Research exploring music's effects on adolescents has suggested that music is associated with positive changes in their emotional well-being. [27,28,98] There is potential to explore the fidelity of intervention delivery, the consistency of delivering ingredients, as well as the possibility that the act of delivering an intervention may provide benefits to the young musicians themselves.

This dissertation takes an innovative approach to music intervention development by bringing clarity to the music activities utilized and the potential for young music facilitators to deliver the activities and their experiences in doing so. In a systematic review, we examined music interventions that contained an active music component, meaning the participants engaged interactively in the music. We calculated effect sizes for the effect of active music on cognitive functioning, emotional well-being, and social connection for older adults with AD+ADRD. We also categorized the active music activities utilizing the Reporting Guidelines for Music-based Interventions (Chapter 2). Through a meta-analysis, we found that active music showed a small, positive effect on cognitive function, 0.30, [95% confidence interval (CI), 0.10, 0.51], and that individual studies of emotional well-being showed positive effect sizes of up to $d = 1.74$. The most popularly used categories of music activities were Re-Creating Music by Singing/Playing Musical Instruments (playing or singing songs that are known to the participants) and Improvisation (creating music in the moment).

We brought these findings forward by designing a digital active music intervention. Knowing that a variety of facilitators had been successful delivering music interventions, we specifically explored the potential for adolescent musicians to deliver the music activities consistently and with positive experiences. We used Lev Vygotsky's Social Constructivism Theory [114], which promotes learning by shared experiences. We tested the ability of adolescent musicians to consistently attend the intervention's sessions and prepare and deliver the activities of the digital active music intervention (Chapter 3). Additionally, we conducted in-depth interviews with the adolescent musicians to understand their characteristics and experiences in delivering the music intervention (Chapter 4). With this, our dissertation explored some important gaps in music intervention development in terms of utilizing specific music activities and testing

and analyzing potential facilitators. [16] To contextualize our findings, we will discuss our results within the background of intervention development and implications for outcomes for both adolescents and older adults living with AD+ADRD.

### 5.1 Importance of Clarity in Music Intervention Development

Older adults living with AD +ADRD can experience a devastating variety of outcomes, including decline of cognitive function[3,] changes in emotional well-being,[4] and decreased social connection.[5] Treatment options vary but are not comprehensive – pharmacological treatments have not been shown to affect emotional and social changes[1] and non-pharmacological treatments have not shown support in all three areas.[115] An increasing number of non-pharmacological treatments are exploring if pairing younger and older generations can introduce mutual benefits.[22,88,95,96]

Music interventions are unique non-pharmacological interventions in that they have been shown to benefit all three areas of decline during AD+ADRD, including cognitive function, emotional well-being, and social connection.[3-5] For adolescents, music has shown a powerful potential to influence the younger generation's sense of self.[27,28,98] However, the lack of consistent reporting on the intervention protocols and their deployment leaves future researchers unable to replicate the intervention. Additionally, this leads to a lack of clarity of the mechanism behind which specific music activities may be exerting their effect on either generation.[17] This gap in understanding is due to a lack of consistent reporting on the intervention protocols and their deployment.[16,36] Researchers have responded by creating guidelines in order to understand the ingredients at work and how they are delivered by music facilitators.[16]

Findings from this dissertation focus on elucidating an understanding about the music activities deployed in music interventions. One of the first levels of distinction is to categorize music as "active" or "passive." Active music has been described as an "interactive engagement in music," while passive music has been described as "listening to music."[18] Researchers have begun calling for a distinction in labeling music active versus passive, as the two activities may have different effects on behavioral and biological responses.[18,116] Our systematic review added to these findings by including only music interventions that had an active music component to better understand how active music may be influencing outcomes.[80] In addition, our review categorizes music activities according to Robb's Reporting Guidelines for Music-based Interventions[16] to further clarify the music activities used.[80] Examples of music activities include "Breathing Entrainment," "Songwriting," and "Listening", among other options. One of the most popular activities utilized in interventions, "Re-Creating Music by Singing/Playing instruments," often corresponded with the use of participant-preferred music. Personalized music is increasingly popular for use with older adults living with AD+ADRD as it is hypothesized that the autobiographical context of songs may connect listeners with their memories.[117] Another popular category, "Improvisation," explores using music to give older adults living with AD+ADRD a sense of expression. This is exemplified in Pavlicevic et al.'s 2013 study of improvisational music, where researchers report "Such spaces offer possibilities for eliciting people's resilience, transforming them into empowered musicians, rather than restricting them to 'persons affected by dementia'."[118] The fact that many interventions in our review utilized multiple music intervention activities aligns with the Developing Complex Interventions framework, which acknowledges the complex nature of interventions with multiple facets.[119]

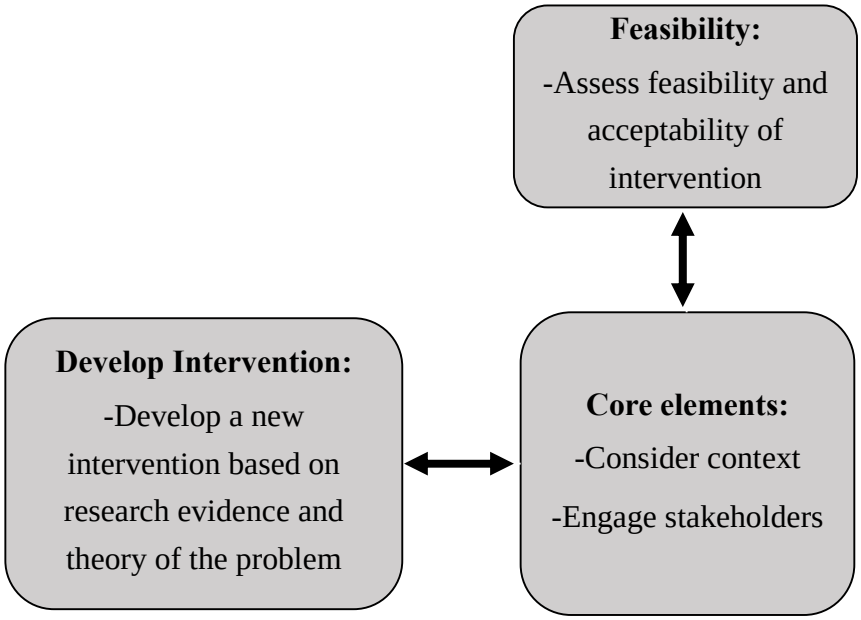



**Figure 10. Elements utilized from the Developing Complex Interventions framework**

These findings allow multiple avenues of exploration. Future researchers may find interest in breaking out individual music activities to compare their efficacy on outcomes. The value of doing so would help researchers be able to deliver patient-centered options, such as if a person living with AD+ADRD identified as a singer, they could be connected with singing interventions. In tandem, music facilitators with specific expertise could be paired to deliver an intervention within their expertise. Additionally, better understanding specific music activities will help researchers and clinicians better target outcome areas – if, for example, group drumming can support depression in AD+ADRD, such an activity can be shared with older adults who are diagnosed or self-identify they live with depression. Researchers can also understand if specific music activities have similar outcomes in the younger and older generations.

Being researchers who are interested in designing interventions in community settings, we acknowledged that utilizing multiple music intervention activities (such as including activities of improvisation and singing along with a song) could create more engaging programming for adolescents to deliver and for older participants with a diversity of music interests and experiences. As such, the updated 2021 Developing Complex Interventions Framework provides apt guidance. See Figure 10.

The findings in this dissertation follow that framework – our systematic review provides the research evidence needed to begin development of a new intervention and theory of the problem. In Chapters 3 and 4 we assess the feasibility and acceptability of the intervention with its adolescent musician facilitators by quantitatively assessing their consistency in delivering the ingredients and qualitatively gauging their experiences delivering the intervention. Additionally, in Chapters 3 and 4 we discuss the context of delivering the intervention digitally in detail, including barriers and facilitators to utilize the technology. We also engaged the adolescent musicians in a stakeholder role, asking them to provide feedback about their experiences delivering the intervention so we could iterate on its training and content.

### 5.1.1 Future Directions

Such a clearly reported intervention development process can inform future research of the mechanism of action of a digital active music intervention. As stated from behavioral intervention researchers, "Cumulative progress in the design of more effective interventions could be improved by developing a more widely shared understanding of the 'mechanisms of action' (MoAs) through which interventions bring about change."[120] An understanding of mechanisms of action, these

researchers assert, would help design interventions that include activities that may be effective and explain those intervention effects. [120]

In better understanding the intervention of active music, we have hypothesized that participating in music may be producing the behavior of music engagement. A potential future direction for this work could be to test if the intervention of active music may cause music engagement, a measurement of participation, and how music engagement may mediate support of emotional well-being in older adults living with AD+ADRD. See Figure 11. Understanding the potential importance of such a mechanism of action could inform future design and scalability of a digital active music intervention, providing focus on what activities are critical to include to produce change and how those activities are causing such change. This knowledge could inform the implementation of an affordable, enjoyable activity that has the potential to support a critical element of well-being in millions of older adults living with AD+ADRD.

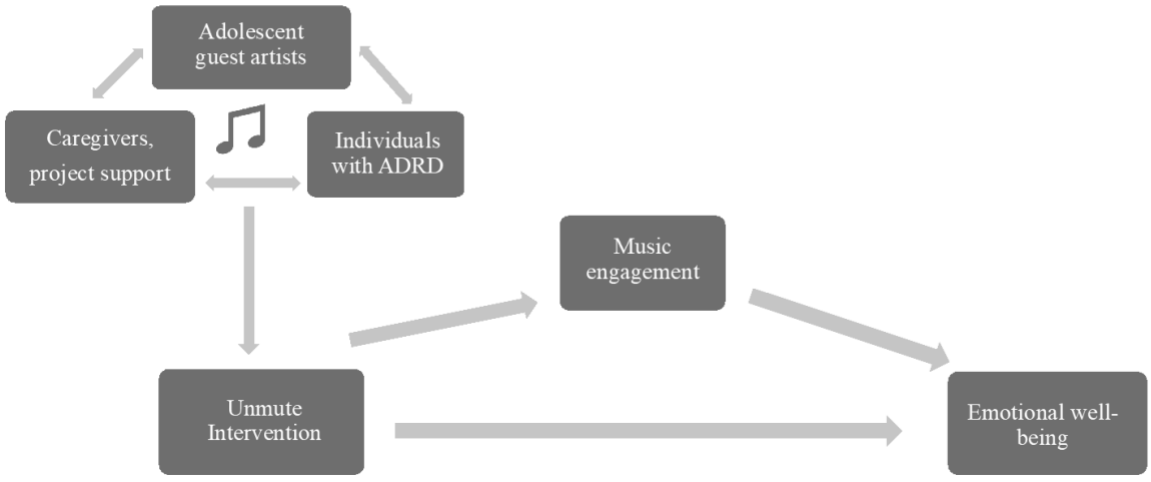



**Figure 11. Conceptual framework for music's mechanism**

## 5.2 Facilitators of Music Interventions and Intergenerational Designs

As music interventions gain more clarity in their reporting, an important facet of the intervention has been largely unexplored – the facilitators of the interventions. In our review of the literature in Chapter 2, we found that the music facilitators varied greatly, including certified music therapists, professional musicians, nurses, and occupational therapists. Inherent in the design of an intervention is an understanding of who may be able to facilitate such an intervention. A researcher's theory about the mechanism of effect in music is affected by the ability of the facilitator to deliver the music as intended. Our findings in Chapter 3 serve to inform an exploratory confirmation that adolescent musicians can consistently prepare and deliver a digital active music intervention. This is important for future studies to understand if they can replicate the intervention, building on our understanding of the potential for music facilitators to be consistent in ingredient delivery. Additionally, we begin to explore in Chapter 4 the characteristics of those facilitators and if administering these specific activities may also have positive effects for adolescent facilitators.

While professional musicians have been utilized in facilitating music interventions, a gap existed to engage a younger generation of musicians. As adolescent musicians acquire the skills necessary to be professional performers, they also are in a unique time in their lives as adolescents. Music supports adolescents' emotional well-being,[27] self-esteem,[28] and identity. [98] Our findings in Chapter 4 furthered this evidence, suggesting that the adolescents experienced positive mental health benefits from facilitating a music intervention. This can inform future research on potential outcomes experienced by adolescents who facilitate digital active music interventions.

Our findings with adolescents as facilitators also further the thinking in the field of intergenerational relationships and design. Though research has often explored the pairing of younger and older generations,[22,88,95,96] it has just begun exploring if the younger generation can facilitate the intervention.[97] Our findings in Chapter 4 about the adolescents' characteristics can inform future researchers about the qualities of adolescents who may be successful facilitating the intervention, aiding in recruitment efforts. It also describes the qualities of adolescents to understand what type of adolescents may be experiencing reported outcomes, prompting future research to explore the variation of adolescents who may experience the most benefits from facilitating a music intervention. For community implementation, these findings can also inform those running music schools and programs serving older adults in recruiting adolescent musicians and understanding the scalability of the program.

This connects with the work being done in intergenerational theory development. To promote shared learning, we utilized Vygotsky's Social Constructivism Theory.[114] The intervention is designed with the idea of creating equality and balance between generations as they explore music in new ways together. Each generation is given the knowledge about how participation benefits the other generation. This is congruent with the model of intergenerativity, in which the interaction between generations creates new knowledge.[121] Continuing to test on a consistent protocol may be able to build evidence for intergenerativity as a theory for future intervention protocols. Additionally, it aligns with implementation research on best practices in intergenerational program delivery. In their 2021 systematic review of the literature, Jarrott et. al cite the practicing of "Promoting mutuality," which includes creating "novel programming that places participants on equal footing."[109]

### 5.2.1 Future Directions

These dissertation findings revealed important understandings about the potential for adolescents to facilitate music interventions and implications for intergenerational theory and practice. Future research may benefit from utilizing and testing the flexibility of characteristics of adolescents to deliver music interventions with fidelity. Additionally, it's critical to better understand the experience of facilitating a music intervention on the lives of the adolescents. By continuing to explore characteristics and experiences, researchers can understand which types of young musicians may benefit the most from participation. With these findings demonstrating potential to support mental health and social empathy, it's crucial to determine which adolescents may benefit from these important supports.

Subsequent research can test and clarify the theory of constructivism and intergenerativity, specifically centering the idea of shared learning and mutual benefit to build on theoretical and implementational knowledge. In exploring facilitation of music interventions, researchers can continue to build an understanding of the theory underlying the musical activities and the interactions between younger and older generations. Such clarification can help future researchers understand the role of music facilitator in building intergenerational relationships as well as delivering specific music content.

## 5.3 Conclusion

This dissertation reports on the positive effects of active music on older adults living with AD+ADRD and explores the use of active music in a digital music intervention utilizing

adolescent musicians as facilitators. These findings advance our knowledge in the fields of music and rehabilitation to better understand the effects of active music and the potential for adolescents to facilitate music interventions for older adults living with AD+ADRD. Next steps include testing the mechanism of music and better understanding its potential effects on both the adolescent musicians and older adults living with AD+ADRD. These findings have implications for a scalable program of adolescent musicians who can consistently deliver a digital active music intervention, potentially providing cognitive, emotional, and social support to millions of older adults with AD+ADRD.

# Appendix A Summary of databases searched and search strategy

**Supplemental Figure S1:** Summary of databases searched and APA PsycInfo® search strategy

| Table | Vendor/ Interface | Database | Date searched | Database update | Searcher(s) |
|---|---|---|---|---|---|
| 1a | Ovid | APA PsycInfo® | March 11, 2020; update March 15, 2021 | 1806 to March Week 1 2020; update 1806 to March Week 2 2021 | Helena M. VonVille; Jennifer L. Dorris |
| 1b | Ovid | Medline® | March 11, 2020; update March 15, 2021 | 1946 to March 10, 2020; update 1946 to March 12, 2021 | Helena M. VonVille; Jennifer L. Dorris |
| 1c | Ebsco | CINAHL® | March 11, 2020; update March 15, 2021 | March 11, 2020; update March 15, 2021 | Helena M. VonVille |
| 1d | Elsevier | EMBASE® | March 11, 2020; update March 15, 2021 | March 11, 2020; update March 15, 2021 | Helena M. VonVille |

**APA PsycInfo® search strategy**

**Provider/Interface** Ovid
**Database** APA PsycInfo®
**Date searched** March 11, 2020; update March 15, 2021
**Database update** 1806 to March Week 1 2020; update 1806 to March Week 2 2021
**Search developer(s)** Helena M. VonVille, Jennifer L. Dorris
**Limit to English?** Yes
**Date Range** No date limits
**Publication Types** Journal articles only
**Search filter source** Adapted from: http://bit.ly/Ovid-Medline-Search-Filters

| | |
|---|---|
| 1 | ("380" or "390").ag. |
| 2 | aging/ or Geriatric Patients/ or geriatrics/ |
| 3 | (aging or geriatric or geriatrics or elderly or (older adj3 (adult or adults or people or participant or participants or person or persons))).ti,ab,id. |
| 4 | 1 or 2 or 3 |
| 5 | alzheimer's disease/ or cognitive ability/ or Cognitive Aging/ or cognitive impairment/ or dementia/ or semantic dementia/ or senile dementia/ |
| 6 | (Alzheimer* or ((cognition or cognitive) adj4 (ageing or aging or decline or impairment)) or dementia or prealzheimer*).ti,ab,id. |
| 7 | (cognitive ageing or cognitive aging or cognitive decline or cognitive impairment).id. |
| 8 | 5 or 6 |
| 9 | 4 and 8 |
| 10 | music/ or music perception/ or music therapy/ or musical ability/ or musical instruments/ or musical pitch/ or musicians/ or rock music/ or rhythm/ or singing/ |
| 11 | (choir or choirs or choral or drumming or drums or guitar or guitars or harmonica or music or musical or musicals or musician or musicians or orchestra or orchestral or orchestras or percussion or piano or sing or rhythm circle* or singing or song or songs or ((string or wind) adj3 (instrument or instruments)) or symphonies or symphony or violin or violins or woodwind or woodwinds).ti,ab,id. |
| 12 | 10 or 11 |
| 13 | 8 and 12 |
| 14 | clinical trial.md. or randomized controlled trials/ or randomized clinical trials/ or ("phase I" or "phase II" or "phase III" or "phase IV" or "phase 1" or "phase 2" or "phase 3" or "phase 4" or ((clinical adj2 trial*) or (controlled adj3 (studies or study or trial or trials)) or (randomi?ed adj7 (studies or study or trial or trials)) or ((single or doubl* or tripl* or treb*) and (blind* or mask*))) or ("4 arm" or "four arm")).ti,ab,id. or intervention.ti. or matched-pair.ab. |
| 15 | 13 and 14 |
| | update |
| 17 | limit 16 to up=20200311-20210315 |

## Appendix B Characteristics of Included Studies

| First author, (publication year) | Diagnosis | Experimental group *N*, age (mean years) on baseline | Control group N, age (mean years) on baseline | Control Intervention and duration/intensity | Music Type | Outcomes Measured: | Interventionist |
|---|---|---|---|---|---|---|---|
| Biasutti (2018) Italy | MCI | *N* = 21, Age = 83.4 (7.8) | *N* = 20, Age = 83.8 (6.2) | *Type of participation:* Gymnastics *Frequency:* 2 weekly *Duration:* 45-min *Length:* 6 weeks | *Type of participation:* Rhythm-music and improvisation. *Frequency:* 2 weekly. *Duration:* 70-min. *Intensity:* 12 sessions *Length:* 6 weeks | Cognitive functioning | Music-psychologist |
| Biasutti (2019) Italy | MMSE > 18 | *N* = 25, Age = 84.0 (7.8) | *N* = 26, Age = 85.1(6.1) | *Type of participation:* Gymnastics, *Frequency:* 2 weekly *Duration:* 45-min *Length:* 6 weeks | *Type of participation:* Rhythm-music and improvisation: *Frequency:* 2 weekly *Duration:* 70-min *Intensity:* 12 sessions *Length:* 6 weeks | Cognitive functioning<br><br>Emotional well-being | Music-psychologist |
| Ceccato (2012) Italy | Mild and moderate dementia | *N* = 27, Age = 85.5 (5.9) | *N* = 23, Age = 87.2 (7.1) | Standard Care | *Type of participation:* Sound Training for Attention and Memory | Cognitive functioning<br><br>Emotional well-being | Music therapists |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | *Frequency:* 2 weekly *Duration:* 45-min *Intensity:* 24 sessions *Length:* 12 weeks | | |
| Chen (2018) Taiwan | Mild and moderate dementia | *N* = 15, Age = 77.3 (9.4) | *N* = 15, Age = 77.3 (10.0) | *Type of participation:* Non-musical cognitive tasks and walking exercises, *Frequency:* 1 weekly *Duration:* 60-min *Length:* 8 weeks | *Type of participation:* Musical Dual-Task Training: *Frequency:* 1 weekly *Duration:* 60-min *Intensity:* 8 sessions *Length:* 8 weeks | Cognitive functioning | Music therapist |
| Cho (2018) U.S. | Mild and moderate AD | *N* = 18, Age = 85.1 (8.7) | Music listening *N* = 17, Age = 87.9 (5.9)<br><br>Control *N* = 17, Age = 87.0 (6.0) | *Type of participation:* Music listening, control group watched "I Love Lucy. *Frequency:* 2 weekly *Duration:* 40-min *Length:* 4 weeks | *Type of participation:* Singing: *Frequency:* 2 weekly *Duration:* 40-min *Intensity:* 8 sessions *Length:* 4 weeks | Emotional well-being | Music therapist |
| Chu (2014) Taiwan | Mild and moderate dementia (severe dementia included but mild and moderate means and SDs reported separately) | Includes all levels of dementia *N* = 52, Age = 82.0 (6.8) | Includes all levels of dementia *N* = 52, Age = 82.0 (6.8) | Usual care | *Type of participation:* Music therapy using gross and fine motor movements *Frequency:* 2 weekly *Duration:* 30-min *Intensity:* 12 sessions *Length:* 6 weeks | Cognitive functioning<br><br>Emotional well-being | Music therapist |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Doi (2017) Japan | MCI | *N* = 67, Age = 76.2 (4.6) | Dance *N* = 67, Age = 75.7 (4.1)<br><br>Control *N* = 67, Age = 76.0 (4.9) | *Type of participation:* Dance *Frequency:* 1 weekly *Duration:* 60-min *Intensity:* 40 sessions *Length*: 40 weeks<br>*Type of participation:* Health education *Frequency:* intermittent *Duration*: 90-min *Intensity:* 3 sessions *Length*: 40 weeks | *Type of participation:* Playing percussion instruments *Frequency:* 1 weekly *Duration:* 60-min *Intensity:* 40 sessions *Length*: 40 weeks | Cognitive functioning | Professional music instructor |
| Ferrero-Arias (2011) Spain | Mild and moderate dementia | *N* = 74, Age = 84.4 (7.0) | *N* = 72, Age = 82.8 (7.6) | *Type of participation:* Self-directed activities: 4 weeks | *Type of participation:* Music therapy with art therapy and psychomotor activity *Frequency:* 5 weekly *Duration:* 50-min *Intensity:* 20 sessions *Length*: 4 weeks | Cognitive functioning<br><br>Emotional well-being | Psychologists and occupational therapists |
| Giovagnoli (2017) Italy | Mild to moderate dementia | *N* = 17, Age = 73.9 (7.7) | Cognitive training *N* = 17, Age = 71.7 (7.9)<br><br>Neuroeducation *N* = 16, Age = 75.3 (5.6) | *Type of participation:* Cognitive training *Frequency:* 2 weekly *Duration:* 45-min *Intensity:* 24 sessions *Length:* 12 weeks *Type of participation:* | *Type of participation:* Active music therapy *Frequency:* 2 weekly *Duration:* 45-min | Cognitive functioning<br><br>Emotional well-being | Music therapist |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | Neuroeducation: *Length:*3 months | *Intensity:* 24 sessions *Length*: 12 weeks | Social engagement | |
| Giovagnoli (2018) Italy | Probable dementia | *N* = 23, Age = 74.3 (5.7) | *N* = 22, Age = 72.0 (7.3) | *Type of participation:* Memantine: 20 mg/day | *Type of participation:* Memantine 20 mg/day + Active Music Therapy *Frequency:* 2 weekly *Duration:* 40-min *Intensity:* 48 sessions *Length*: 24 weeks | Cognitive functioning<br><br>Emotional well-being<br><br>Social engagement | Music therapist |
| Harrison (2010) Australia | Early-to-mod dementia | *N* = 47 Age range = 65-95+ | *N* = 47 Age range = 65-95+ | *Type of participation:* Reading *Frequency:* 3 weekly *Duration:* 40-min *Intensity:* 24 sessions *Length:* 8 weeks | *Type of participation:* Song-singing and active listening *Frequency:* 3 weekly *Duration:* 40-min *Intensity:* 24 sessions *Length*: 8 weeks | Emotional well-being | Musicians trained in education |
| Hsu (2015) U.K. | Moderate dementia | *N* = 9, Age = 84.6 (6.6) | *N* = 8, Age = 82.5 (13.0) | *Type of participation:* Standard care | *Type of participation:* Listening and improvisation *Frequency:* 1 weekly *Duration:* 30-min *Length*: 5 months | Emotional well-being | Music therapist |
| Kim (2016) Korea | Mild dementia | *N* = 32, Age = 78.4 (1.0) | *N* = 32, Age = 78.5 (1.7) | *Type of participation:* Pharmacological treatment as usual | *Type of participation:* Music with art, | Cognitive functioning | Occupational therapists |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | recollection, horticulture, and pharmacotherapy *Frequency:* 5 weekly *Duration:* 60-min *Length*: 6 months | Emotional well-being | |
| Kim (2020) Korea | Mild dementia | *N* = 18, Age = 80.6 (5.1) | *N* = 17, Age = 77.9 (5.5) | *Type of participation:* Regular activities at daycare centers (physical activity, recreation, watching TV) *Frequency:* 5 weekly *Duration:* 60-min *Length:* 24 sessions | *Type of participation:* OT program including music with art, horticulture, physical, instrumental activities of daily living *Frequency:* 5 weekly *Duration:* 60-min *Length:* 24 sessions | Cognitive functioning<br>Emotional well-being | Occupational therapist |
| Liu (2021) Taiwan | Mild and moderate dementia | *N* = 25, Age = 86.6 (4.5) | *N* = 25, Age = 86.9 (5.7) | *Type of participation:* Rest and reading session *Frequency:* 1 weekly *Duration:* 60-min *Length:* 12 weeks | *Type of participation:* Playing percussion instruments to familiar songs *Frequency:* 1 weekly *Duration:* 60-min *Length:* 12 weeks | Emotional well-being | Trained music facilitator |
| Lyu (2018) China | Included mild, moderate, and severe. Mild and | *N* = 67, Age includes all levels of dementia, 68.9 (7.1) | Lyric Reading *N* = 65, Age includes all levels of dementia, 70.3 (8.3) | *Type of participation:* Lyric reading: *Frequency*: 2 daily *Duration:* 30-40 min *Length*: 3 months *Type of participation:* | *Type of participation:* Singing and listening to favorite songs *Frequency*: 2 | Cognitive functioning<br>Emotional well-being | Therapist |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | moderate are analyzed separately for outcomes. | | Standard care *N* = 67, Age includes all levels of dementia, 69.9 (7.9) | Standard care as usual. | daily *Duration:* 30-40 min *Length*: 3 months | | |
| Park (2020) U.S. | Mild, moderate, and severe. Mean MMSE was 14.7 | *N* = 10, Age includes all groups: 84.3 (7.7) | Chair yoga *N* = 10, Age includes all groups: 84.3 (7.7)<br><br>Chair-based exercise *N* = 11; Age includes all groups: 84.3 (7.7) | *Type of participation:* Chair yoga *Frequency*: 2 weekly *Duration:* 45-min *Intensity:* 24 sessions *Length*:<br>12 weeks<br>*Type of participation:* Chair-based exercise 2 weekly *Duration:* 45-min *Intensity:* 24 sessions *Length*:<br>12 weeks | *Type of participation:* Singing, movement, and cognitive stimulation *Frequency*: 2 weekly *Duration:* 45-min *Intensity:* 24 sessions *Length*:12 weeks | Emotional well-being | Music therapist |
| Pongan (2017) France | Mild AD | *N* = 33, Age = 78.8 (7.4) | *N* = 32, Age = 80.2 (5.7) | *Type of participation:* Painting *Frequency*: 1 weekly *Duration:* 120-min *Intensity:* 12 sessions *Length*: 12 weeks | *Type of participation:* Singing *Frequency*: 1 weekly *Duration:* 120-min *Intensity:* 12 sessions *Length*:12 weeks | Cognitive functioning<br><br>Emotional well-being | Professional choir conductor and psychologist team |
| Raglio (2010) Italy | Mild or Moderate AD | *N* = 10, Age = 84.0 (6.0) | *N* = 10, Age = 87.0 (6.0) | *Type of participation:* Not structured time including educational | *Type of participation:* Melodic percussion | Cognitive functioning | Music therapist |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | and occupational activities. | improvisation *Frequency*: 2 weekly *Duration:* 30-min *Intensity:* 30 sessions *Length*: 15 weeks | Emotional well-being | |
| Särkämö (2014) and Särkämö (2016) Finland | Mild to moderate dementia | *N* = 30, Age = 78.5 (10.4) | Music listening control *N* = 29, Age = 79.4 (10.1)<br><br>Usual care control group *N* = 30, Age = 78.4 (11.6) | *Type of participation:* Music listening group *Frequency*: 1 weekly *Duration:* 90-min *Length*:10 weeks *Type of participation:* Usual care: not structured. | *Type of participation:* Singing *Frequency*: 1 weekly *Duration:* 90-min *Intensity:* 10 sessions *Length:* 10 weeks | Cognitive functioning<br><br>Emotional well-being | Trained music teacher or music therapist |
| Satoh (2017) Japan | Mild to moderate dementia | *N* = 43, Age = 87.0 (5.4) | *N* = 42, Age = 87.4 (4.4) | *Type of participation:* Cognitive stimulation *Frequency*: 1 weekly *Duration:* 40-min *Intensity:* 24 sessions *Length*: 6 months | *Type of participation:* Music integrated with exercise *Frequency*: 1 weekly *Duration:* 40-min *Intensity:* 24 sessions *Length*: 6 months | Cognitive functioning<br><br>Emotional well-being | Professional musicians who are also licensed physical trainers |

## Appendix C Music intervention content

| **First author (Year)** | **Listening** (Participants listen to live or recorded music) | **Music-Assisted Relaxation** (Music used to structure relaxation exercises) | **Re-Creating Music by Singing/Playing Instruments** (Participants sing and/or play pre-composed songs/music) | **Improvisation** (Participants or interventionist creates music in the moment) | **Lyric Analysis** (Participants discuss meaning of song lyrics) | **Songwriting** (Participants engage in lyric writing and/or musical composition) | **Imagery** (Music used to support or facilitate visual imagery) | **Movement** (Music used to structure, facilitate, or encourage movement) | **Breathing Entrainment** (Rhythmic/temporal qualities of music structure rate of breathing; synchronization between breathing/rate of music.) | **Instrument/ Vocal Play** (Play that combines non-music play materials with singing and/or playing instruments (e.g., children's finger puppet action songs.) | **Other** (Specific music intervention approach not applicable to other categories.) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Biasutti (2018) | | | X | X | | | | | | | |
| Biasutti (2019) | | | X | X | | | | | | | |
| Ceccato (2012) | X | | X | | | | | X | | | X* |
| Chen (2018) | | | X | X | | | | X | | | X ** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Cho (2018) | | | X | | | | |
| Chu (2014) | X | | X | X | | | |
| Doi (2017) | | | X | X | | | |
| Ferrero-Arias (2011) | X | | X | X | | | |
| Giovagnoli (2017) | | | | X | | | |
| Giovagnoli (2018) | | | | X | | | |
| Harrison (2010) | X | | X | | | | |
| Hsu (2015) | X | | | X | | | |
| Kim (2016) | | | X | | | | |
| Kim (2020) | X | | X | | | | X |
| Liu (2021) | | | X | | | | |
| Lyu (2018) | X | | X | | | | |
| Park (2020) | | | X | | | | X |
| Pongan (2017) | | | X | | | | |
| Raglio (2010) | | | | X | | | |
| Särkämö | | | X | | | X | X |

| | | | | | |
|---|---|---|---|---|---|
| (2014/2016) | | | | | |
| Satoh (2017) | X | | X | X | |

* Attention exercises where participants must react to a stimulus by clapping in one scenario (hearing a drum) but refraining during a different scenario (drum is preceded by cymbal)

** Dual task training asks participants to cue their sound off of different stimuli and has graded exercises.

## Appendix D Appendix D Risk of bias of included studies

| | Selection Bias (risk of bias arising from the randomization process) | | | Performance Bias (effect of deviations from the intended intervention) | Detection Bias | Attrition Bias | Reporting Bias | |
|---|---|---|---|---|---|---|---|---|
| **First Author (Year)** | **Random sequence generation** | **Allocation concealment** | **Baseline differences between intervention groups** | **Blinding of participants and personnel during the trial and adherence** | **Measurement of the outcome** | **Incomplete outcome data** | **Risk of bias in selection of the reported result** | **Overall risk of bias Assessment** |
| Biasutti (2018) | X | X | X | X | X | X | X | Low |
| Biasutti (2019) | X | X | X | X | X | X | X | Low |
| Ceccato (2012) | X | X | X | X | X | X | X | Low |
| Chen (2018) | X | X | X | X | X | X | X | Low |
| Cho (2018) | X | X | X | X | X | X | X | Low |
| Chu (2014) | X | X | X | X | X | X | X | Low |
| Doi (2017) | X | X | X | X | X | X | X | Low |
| Ferrero-Arias (2011) | X | X | X | X | X | X | X | Low |
| Giovagnoli (2017) | X | X | X | X | X | X | X | Low |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Giovagnoli (2018) | X | X | X | X | X | X | X | Low |
| Harrison (2010) | X | X | X | X | X | X | X | Low |
| Hsu (2015) | X | X | X | X | X | X | X | Low |
| Kim (2016) | X | Some concerns | X | X | X | X | X | Some concerns |
| Kim (2020) | X | Some concerns | X | X | X | X | X | Some concerns |
| Liu (2021) | X | X | X | X | X | X | X | Low |
| Lyu (2018) | X | X | X | X | X | X | X | Low |
| Park (2020) | X | X | X | X | X | X | X | Low |
| Pongan (2017) | X | X | X | X | X | X | X | Low |
| Raglio (2010) | X | X | X | X | X | X | X | Low |
| Särkämö (2014/2016) | X | X | X | X | X | X | X | Low |
| Satoh (2017) | Some concerns | Some concerns | X | X | X | X | X | Some concerns |

✓ – high risk; X – low risk; some concerns

**Overall risk of bias assessment:**

**Low risk of bias:** The study is judged to be at **low risk of bias for all domains** for this result.

**Some concerns:** The study is judged to raise **some concerns** in at least one domain for this result, but not to be at high risk of bias for any domain.

**High risk of bias:** The study is judged to be at **high risk of bias** in at least one domain for this result. Or: The study is judged to have **some concerns** for **multiple domains** in a way that substantially lowers confidence in the result.

## Appendix E Effect sizes

| Study | Control | Outcome measure | Effect Size | Confidence Intervals |
|---|---|---|---|---|
| **Cognitive functioning** | | | | |
| Biasutti (2018) | Gymnastics | Mini-Mental State Examination | 0.39 | (-0.24, 1.00) |
| Chu (2014) | Usual care | Mini-Mental State Examination | Mild AD: +2.81<br>Mod AD: 0.50 | Data not available |
| Giovagnoli (2017) | Cognitive training | Mini-Mental State Examination | -0.24 | (-0.91, 0.44) |
| Giovagnoli (2018) | Pharmacology | Mini-Mental State Examination | 0.05 | (-0.53, 0.63) |
| Kim (2016) | Pharmacology | Korean Mini-Mental State Examination | 0.65 | (0.14, 1.14) |
| Kim (2020) | Daycare center activities | Korean Mini-Mental State Examination | 0.98 | (0.25, 1.65) |
| Lyu (2018) | Lyric reading | Mini-Mental State Examination | Mild AD: 0.01<br>Mod AD: 0.02 | (-0.48, 0.50)<br>(-0.46, 0.49) |
| Pongan (2017) | Painting | Frontal Assessment Battery | 0.42 | (-0.08, 0.91) |
| Raglio (2010) | Educational + occupational activities | Mini-Mental State Examination | 0.50 | (-0.41, 1.37) |
| Särkämö (2014/2016) | Music listening | Mini-Mental State Examination | 0.51 | (-0.02, 1.02) |
| Satoh (2017) | Cognitive stimulation | Mini-Mental State Examination | -0.14 | (-0.57, 0.29) |
| **Quality of Life** | | | | |
| Cho (2018) | Music listening | Quality of Life -Alzheimer's Disease | 0.86 | (0.15, 1.53) |
| Kim (2016) | Pharmacology | Quality of Life -Alzheimer's Disease | 0.12 | (-0.37, 0.61) |
| Kim (2020) | Daycare center activities | Geriatric Quality of Life-Dementia Scale | 1.08 | (0.35, 1.76) |
| Park (2020) | Chair yoga | Quality of Life -Alzheimer's Disease | -1.24 | (-2.14, -0.24) |
| Pongan (2017) | Painting | EuroQol-5D | 0.04 | (-0.45, 0.52) |

| | | | | |
|---|---|---|---|---|
| Särkämö (2014/2016) | Music listening | Quality of Life -Alzheimer's Disease | -0.30 | (-0.81, 0.22) |
| **Mood** | | | | |
| Cho (2018) | Music listening | Positive and Negative Affect Schedule | Positive: 1.74<br>Negative: -1.01 | (0.92, 2.47)<br>(-1.70, -0.30) |
| Särkämö (2014/2016) | Music listening | Cornell Brown Scale-Mood | 0.0 | (-0.51, 0.51) |
| **Depression** | | | | |
| Giovagnoli (2017) | Cognitive training | Beck Depression Inventory | 0.77 | (0.05,1.44) |
| Giovagnoli (2018) | Pharmacology | Neuropsychiatric Inventory – Depression | -0.01 | (-0.60, 0.57) |
| Kim (2016) | Pharmacology | Geriatric Depression Scale | -0.05 | (-0.54, 0.44) |
| Kim (2020) | Daycare center activities | Geriatric Depression Scale-Short Form (Korean) | -0.75 | (-1.42, -0.05) |
| Liu (2021) | Rest and reading | Geriatric Depression Scale | -0.25 | (-0.80, 0.31) |
| Park (2020) | Chair yoga | Hospital Anxiety and Depression Scale | 0.89 | (-0.07, 1.76) |
| **Anxiety** | | | | |
| Giovagnoli (2017) | Cognitive training | State Trait Anxiety Inventory Y-1<br>State Trait Anxiety Inventory Y-2 | 0.08<br>0.50 | (-0.60, 0.75)<br>(-0.20, 1.17) |
| Giovagnoli (2018) | Pharmacology | Neuropsychiatric Inventory - Anxiety | 0.23 | (-0.36, 0.81) |
| Liu (2021) | Rest and reading | Hamilton Anxiety Rating Scale | -1.71 | (-2.33, -1.04) |
| Pongan (2017) | Painting | State Trait Anxiety | 0.42 | (-0.08, 0.90) |
| Park (2020) | Chair Yoga | Hospital Anxiety and Depression Scale | -0.12 | (-0.99, 0.76) |
| **Social Engagement** | | | | |
| Giovagnoli (2017) | Cognitive training | Lubben Social Network Scale | -0.91 | (-1.60, -0.19) |
| Giovagnoli (2018) | Pharmacology | Lubben Social Network Scale | -0.69 | (-1.28, -0.08) |

## Appendix F Attendance measure.

| | Intervention training | Dementia training | Music Mentor Session | Dementia 360 meet and greet | Music Mentor Session | Intervention Session 1 | Music Mentor Session | Intervention Session 2 | Music Mentor Session | Intervention Session 3 |
|---|---|---|---|---|---|---|---|---|---|---|
| Teen A | | | | | | | | | | |

0 = no; 1 = yes

## Appendix G Program preparation measure

**Program Preparation (to be filled out by the Music Mentor during each session):**

1. How many minutes did the adolescent musician estimate they spent preparing (Numerical)
2. How many minutes did the session take? (Numerical)
3. Did the participant prepare the intervention?
    a. 0 = not completed (no plan has been made)
    b. 1 = completed; unsatisfactory (a plan has been made but the participant does not have ideas for all three ingredients)
    c. 2 = completed; satisfactory (a plan has been made and the participant has ideas for all three ingredients)

## Appendix H Fidelity review form measure

| **Project Unmute: Supporting Musical Appreciation, Theoretical Knowledge, and Interaction** | | |
|---|---|---|
| **Teaching of ingredients by instructor** | | |
| **Scoring Rubric**<br>**888=N/A, 999=missing** | No=0<br>Yes=1 | Inadequate=0<br>Adequate=1<br>Exceptional=2 |
| **Performance Standard** | Adherence (Did you do it?) | Competence (How well did you do it?) |
| 1. Music Appreciation: Instructor provides a listening example that is informed by members' preferences and facilitates appreciation by providing context. | | |
| 2. Theory: Instructor introduces a musical concept and gives examples of how it can be used. | | |
| 3. Interaction: Instructor create an opportunity for participants to participate in music. | | |

A description of criteria for each performance standard is provided below:

**Music Appreciation**

- 0=Inadequate: Does not provide a listening example.
- 1=Adequate: Provides a listening example
- 2=Exemplar: Provides a listening example AND provides context or clearly gives information on what to listen for.

**Music Theory**

- 0=Inadequate: Does not introduce a music concept.
- 1=Adequate: Introduces a musical concept.
- 2=Exemplar: Introduces a musical concept AND gives examples of how the musical concept can be used in musical works.

**Interaction**

- 0=Inadequate: Does not include an interaction exercise.
- 1=Adequate: Creates an opportunity to participate in music
- 2=Exemplar: Creates an opportunity to participate in music AND provides clear ways to participate and/or scaffolds activity to include participants.

**Appendix I Intervention reporting using the Reporting Guidelines for Music-Based Interventions[16].**

| **Project Unmute Intervention Description** |
|---|
| *Intervention Theory* |
| This intervention utilizes the framework of Vygotsky's model of Social Constructivism, [85] an educational framework that posits that learning happens during the shared experiences of teacher, students, and other class members. This framework facilitates a non-hierarchical context between the adolescent musicians, older adults living with dementia, and research and community partner staff. Creating such an "equal footing" allows all members of the group to share ideas and participate in the music. The music selected for the sessions has been identified as preferred by the older adult participants, this music was selected due to prior research demonstrating success with the use of preferred music and to encourage attentional responses to familiar music. The construction of a shared environment with preferred music is designed to empower the adolescent musicians to learn to deliver and speak about music in a new way, and emotionally and socially support the older adults. |
| *Intervention Content* |
| The intervention is comprised of three active ingredients: 1) Music Appreciation, in which participants perform a song preferred by the older adults, 2) Theory, in which participants introduce a musical concept and demonstrate how it is used in the song and 3) Interaction, in which participants create an opportunity for the older adults to interact with the music. In each ingredient, adolescent musicians were encouraged to scaffold discussion based on individual interaction, such as by asking follow-up questions or having several interactive activities prepared to maximize engagement. |
| *Person selecting the music* |
| The music was selected after the research team spoke with each participating family and compiled a list of preferred music. |
| *Music* |
| Sheet music was purchased or transcribed and arranged by the study team and/or adolescent musicians for the following songs: "Happy Birthday," "You Make Me Feel So Young," "Grand Ole' Flag," "America the Beautiful," "Amazing Grace," "Take Five," "Yesterday," "Danny Boy," Eight Days a Week," "Fly Me to the Moon," "Bridge Over Troubled Water," "This Land is Your Land," "Tennessee Waltz," "When Irish Eyes are Smiling," "I'll Take You Home Again, Kathleen," "My Wild Irish Rose," "Beer Barrell Polka," "Ring of Fire," "Back in the Saddle Again," "The Old Bog Road," "If I Were a Rich Man," "Take Me Home, Country Road," "Unchained Melody," and "Leaving on a Jet Plane." In addition to performing the song on their instruments, many adolescent musicians shared the original song via a publicly available recording on YouTube. When asked by the older adults, adolescent musicians at times would additionally perform music they were working on for their own training, typically classical solo or orchestral works. |
| *Music delivery method (live or recorded)* |

All music was delivered via Zoom. Adolescent musicians both performed live and shared recordings of themselves playing. All older adults participating in sessions were able to control the volume of the music on their electronic device. No older adult utilized headphones.

The music was delivered by the individual adolescent musicians. Two adolescent musicians agreed to accompany one another for their intervention delivery. Every session featured an interactive activity, in which the participants had some level of active engagement in the music, including singing along, choosing dynamics, clapping rhythms, etc.

*Intervention materials*

The research team provided sheet music, either purchased or arranged, to all the adolescent musicians for reference and use. Additionally, adolescent musicians received a manualized protocol of the music intervention and tips for performing music for older adults living with dementia. For the Music Mentors, the research team provided a checklist of supporting questions to inform mentorship sessions.

*Intervention strategies*

Intervention strategies included: Recreating Music by Singing/Playing Instruments (in which the adolescent musicians used their instruments to perform a version of a familiar song), Improvisation (in which adolescent musicians provided an interactive music activity and were flexible to the feedback of the older adults), and Music Listening (in which adolescent musicians provided a listening example of the preferred song).

*Intervention delivery schedule*

Each adolescent musician was expected to attend 10 intervention sessions, including training sessions. An additional 11$^{th}$ session was made available in the case that the study team identified that the adolescent needed to be retrained. The intervention protocol and dementia training session were scheduled to last one hour each. The Music Mentor sessions were scheduled for an hour. Each adolescent musician prepared 30-minute intervention sessions. To accommodate scheduling needs of the adolescent musicians and older adults, the research team scheduled 10 intervention sessions that featured two adolescent musicians and lasted one hour in total. Four sessions featured one adolescent musician and lasted 30 minutes.

*Interventionist*

Adolescent musicians needed to be 12 to 18 years old to participate in delivering the intervention. In addition, they needed to confirm prior musical experience and a willingness to deliver the intervention in English. Eight adolescent musicians served as interventionists.

*Treatment fidelity*

There was a manualized protocol developed by the team in prior program development studies. There were two group training sessions with the students; the first training discussed implementing the activities of the music program and the second training focused on how to perform for older adults living with dementia. In addition, each adolescent musician met with a college-aged Music Mentor trained in the intervention twice before their first performance and at least once before their second and third performances. Adolescent musicians reported the number of minutes they prepared for each Music Mentor session, and Music Mentors rated their preparation. Intervention performances were recorded and monitored by the PI.

*Setting*

The intervention was delivered via Zoom. Students utilized both practice rooms in their schools and rooms in their residential homes. Older adults accessed Zooms from their homes. During one session a student's practice room was close to the orchestra rehearsal room and

| |
|---|
| ambient noise from the rehearsal could be heard on the Zoom call. No other interruptions were noted, and there were no breaks in internet service during the sessions. |
| *Unit of delivery* |
| The intervention was delivered to groups of individuals; older adults living with dementia joined the Zoom calls with their caregivers. The number of families joining the sessions ranged from two to six families, with an average number of four families per session. In addition, one staff member from Dementia360 joined, as did the PI. |

**Appendix J Explication of activities used by adolescents for each intervention ingredient.**

| Intervention Ingredient | Example of How Participant Performed Ingredient |
|---|---|
| Music Appreciation | The adolescent provided background information for "My Wild Irish Rose" then performed it live on the cello. |
| Music Appreciation | The adolescent performed the song "Yesterday" live on French horn and played a recording of the original song for participants. |
| Theory | The adolescent shared the sheet music to "Take Five" and explained fingering markings and the different hand and finger positions on the bass. They also discussed the differences between arco and pizzicato. |
| Theory | The adolescent introduced different articulation markings and showed examples of each in sheet music that they shared with the audience. They also demonstrated each articulation on the saxophone. |
| Interaction | The adolescent played a recording of the song while leading the group in a clapping activity. At the end, they shared the lyrics and asks participants to sing along. |
| Interaction | The adolescent asked participants to choose which harp pedals to push down while they played and demonstrated the different sounds. |

## Appendix K Interview Guide

### Characteristics

1. Tell me about what motivated you to participate in this music program.
    a. Will this project be applicable toward service hours you may need for school, scholarships, or another organization?
2. What drew you to music?
    a. Prompt: Did you listen to music at home at a young age, know someone who played an instrument?
3. What motivates you to be in music right now?
    a. Do you feel motivated by yourself, such as that you love to play/have particular music that you play that you feel connected to? Or are you motivated when people in your life, such as your parents or teachers, encourage you to play?
4. What do you think would make you a better musician?
    a. Do you want to get better at your instrument, understand more about music theory, know more about music history? Learn techniques like composition or improvisation?
5. Describe all the ways you have learned or been taught music
6. Describe what practicing your instrument looks like, including how often you do so
7. How would you react to something not going as planned? How would you feel?
8. How important is being creative to your overall and day-to-day life?
    a. How does creativity manifest in your life? What does that look like for you?
9. Would you describe yourself as an introvert, an extrovert, or a combination of the two?
10. What does responsibility look like in your day-to-day life?
    a. When do you have to be responsible? Does it come naturally to you?
11. How does it make you feel to engage with people who are different than you in certain ways?
    a. For example, if they were different in terms of abilities, their background, the way they live their lives?
12. How would you describe your ability to focus on different musical activities?
    a. When are you the most engaged or the most focused?
    b. Are there any things that help you focus?
    c. About how long do you stay focused –for example, 15, 20, 30, 45 minutes?

**Experiences: 1) Older adults 2) Training 3) Program Implementation 4) What they learned**

1. How did you feel about older adults with Alzheimer's before the program?
2. How did you feel about older adults with Alzheimer's after the program?
    a. How did it feel interacting with the older adults during the music program?

3. Tell me about your experience with the initial training, where you learned about the music program and its components.
    a. Did you know what to do to prepare?
    b. What worked, and what could be better?
4. Tell me about your experience with the "meet-and-greet" with Dementia360.
    a. How did this help you plan your music program?
    b. What was your experience like interacting with them?
5. Tell me about working with your Music Mentor:
    a. How did interactions with your mentors influence your preparation of your guest artist program?
    b. What recommendations can you make for future teens and mentors?
6. Overall, how successful did you feel you were in delivering your guest artist program?
    a. Discuss the components of the guest artist program. How did it feel preparing and performing each of these?
    b. What went well, and what didn't?
    c. Are there any parts of the music program that should be changed for the future?
7. What did you learn after participating in this program?
8. Tell me about if this program built on existing skills or helped you learn new skills
9. In what ways was this process similar to ways you have engaged and perceived music in the past?
    a. In what ways was this process different to ways you have engaged and perceived music in the past?
10. Do you feel like this program was a good fit for you?
    a. Why?
    b. (If applicable): Why would you continue?
    c. (If applicable): What would you change?
    d. What did you like and dislike about the program?
11. Would you be willing to continue this type of program in the future, yes or no?

## Appendix L Lessons learned

| Topic | Lesson Learned | Solution |
|---|---|---|
| **Characteristics:**<br>Adolescent musicians' motivation to participate | Understanding what motivates adolescent musicians to participate. | Findings suggest that future adolescents may be motivated by 1) introductions to the program, 2) previous experience with someone living with dementia, and/or 3) the desire to use music to help others |
| **Characteristics:**<br>Adolescent musicians' self-perceived personality traits | Exploring what types of personalities participate in the facilitation of Unmute. | Researchers found most adolescents described themselves as a combination of introvert and extrovert, all mentioned at least one scenario where they felt comfortable being an extrovert. |
| **Experiences:**<br>Providing a fuller appreciation of the older adults' preferred song | Integrating the adolescent musicians' suggestion that the Music Appreciation ingredient include both an original recording of the song and a rendition of the song by the adolescent musician on their instrument. | Suggest in the intervention protocol that adolescent musicians can also play the original recording of the preferred song. |
| **Experiences:**<br>How to communicate with older adults living with AD+ADRD. | Understanding that the current dementia training emphasized how to communicate with those with more severe AD+ADRD. | Expand dementia training to discuss the range of communication styles of those living with AD+ADRD. |

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