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Group Music Training as a Multimodal Cognitive Intervention for Older Adults

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Music training may provide an effective mean of enhancing cognitive function in older adults. However, age-related differences in learning, vision and brain plasticity may limit traditional teaching methods effectiveness for older adult learners. The Maine Understanding Sensory Integration and Cognition Project aimed to develop an economical, older-adult-friendly music intervention. The current study presents the pilot data on the effect of music training on social, emotional, and cognitive function. Results, methodology, and challenges with solutions encountered during implementation of a group music intervention for older adults are reported. Community-based participatory research methods were used to enhance recruitment of socioeconomically diverse older adults and solicit participatory feedback. Thirty-five socioeconomically diverse older adults (M_{age} = 70, SD = 5.12) completed the program. Participants took part in 12 weekly 1-hr recorder group lessons and underwent comprehensive pre- and postintervention neuropsychological assessments. Teaching manuals designed specifically for older adults were developed to overcome identified learning barriers in music learning. Results indicated improved executive function, global cognition, verbal fluency, and visual memory performance following the intervention, $ps < .05$. Participants universally reported the group provided valuable socialization and camaraderie. Subjective improvements in cognition, self-efficacy and emotional well-being as a result of participating in the music group were also found. Music training is a cognitively stimulating activity that has real-life applications. The Maine Understanding Sensory Integration and Cognition Project's manualized group intervention may provide an engaging and efficient method to enhance social and cognitive function in older adults.

Keywords: cognitive decline, executive function, diverse, wellness, self-efficacy

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Developing interventions that might prevent or delay cognitive decline is critical given the rapidly growing aging population and anticipated increase in dementia prevalence. A growing body of evidence indicates that while growing in popularity and proliferating at a remarkable rate, the majority of "brain-training" programs lack empirical support in their ability to provide cognitive benefits that generalize beyond the testing situation (see Green & Bavelier, 2008; Simons et al., 2016). Such findings are highly discouraging given nearly 14 million individuals by 2050 are projected to have late onset Alzheimer's disease (Centers for Disease Control and Prevention, 2014).

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Music has several tangible benefits including being associated with quality of life (QoL), reduced stress, as well as improved mood in older adults with depression or a dementia disorder (e.g., Chu et al., 2014; Hars, Herrmann, Gold, Rizzoli, & Trombetti, 2014; Rohwer & Coffman, 2006; Thoma et al., 2013). Notably, there is also preliminary evidence to suggest that musical training may improve cognition. Research indicates that music training is a multimodal activity that involves coordinating of sensory and motor sequences with planned actions that require higher cognitive resources (e.g., Amad et al., 2016; Gaser & Schlaug, 2003; Hanna-Pladdy & MacKay, 2011; Walker, 2016). Theoretically, these actions increase neural plasticity with age as it involves the activation of and integration of multiple neural functions (Benz, Sellaro, Hommel, & Colzato, 2016; Román-Caballero, Arnedo, Triviño, & Lupiáñez, 2018; Wan & Schlaug, 2010). Music training in particular has been associated with frontal lobe function and higher visuospatial, working memory and executive function performance across the life span (Bergman Nutley, Darki, & Klingberg, 2014; Bidelman & Alain, 2015; Bugos, Kochar, & Maxfield, 2015; Bugos, Perlstein, McCrae, Brophy, & Bedenbaugh, 2007; Hanna-Pladdy & MacKay, 2011; Moussard, Bermudez, Alain, Tays, & Moreno, 2016). However, the majority of evidence in support of the cognitive enhancing effects of music training is based on correlational studies that compared musicians to nonmusicians (Benz et al., 2016). Thus, there is a need for more experimental studies that investigate the relationship between cognition and musical training paradigms.

Results have been promising for the few studies that have experimentally tested the effect of music training on cognition in older adults using individualized piano instruction (IPI; See Román-Caballero et al., 2018). These studies demonstrated improvements in executive function and attention in response to the music training. However, while the IPI study findings are encouraging, the intensive nature of IPI training and the need for regular access to a piano, may place limits on the scalability of IPI as a cognitive intervention due to cost, reach and adoption issues. These limitations are significant as they will likely affect music training access for low socioeconomic status individuals, who are also at greater risk of declines in health. In addition to scalability concerns, it is also of interest that more solitary activities (e.g., music listening) can produce worse functional outcomes than more social and productive activities in later life (Menec, 2003). Whereas, group musical activity associates with decreased feelings of loneliness by providing regular and meaningful opportunities to meet new people and build social support (Johnson et al., 2018). In this respect, we hypothesized that music training in a group format would not only be more economical but also would provide important social, emotional and cognitive benefits.

Music training may provide a rewarding and effective means of enhancing cognitive function and socialization in older adults (Habibi & Damasio, 2014). The Maine Understanding Sensory Integration and Cognition (MUSIC) Project aimed to develop an economical and older adult friendly music intervention. The current study presents the pilot data on the effect of music training on social, emotional and cognitive function. The MUSIC Project provided 12 weekly 1-hr music lessons in an economical group format using an inexpensive, portable recorder to test the hypothesis that music learning can enhance cognitive function in adults 55-years or older. We specifically hypothesized that music training would associate with (a) improved performance on measures of executive attention/processing speed, working memory, phonemic fluency, and visuospatial function and (b) subjective improvements on measures of cognition, socialization, well-being and efficacy. Challenges with potential solutions to the implementation of a music learning program within the community are also described here.

Method

Recruitment and Screening

The MUSIC Project aimed to develop an affordable and older adult friendly music intervention. Toward these objectives, community-based participatory research (CBPR) methods were used to enhance recruitment of socioeconomically diverse older adult sample and obtain participant feedback to apply this knowledge to the development of a music program designed specifically to teach music to older adult learners.

CBPR outreach and recruitment efforts for the study were in collaboration with the University of Maine Center of Aging, Eastern Area of Aging Agency, Bangor YMCA, and low-income independent living community housing residence coordinators within the New England region. The study purposefully conducted study procedures at low-income group residences or at easily accessible locations within the community to reduce transportation barriers to selectively enhance recruitment of economically insecure older adults, given this is an understudied population who is at higher risk for dementia (Evans et al., 1997; Ursache & Noble, 2016).

Study inclusion criteria were wide to improve generalizability of the intervention to those with mild cognitive impairments and/or depressive symptoms. We aimed to recruit a final sample size of at least 31 older adults based on Bugos and colleagues' (2007) IPI study (experimental group $n = 16$), which suggested this would sufficiently power us to detect effects on cognitive performance and also allow for greater clinical heterogeneity within our sample. Inclusion criteria included being aged 55 or older, willing to participate in the 12 weekly 1-hr sessions, and undergo the assessment measures at two time points. Individuals with severe cognitive impairments (Montreal Cognitive Assessment [MoCA, Nasreddine et al., 2005] scores <18), severe depression (Geriatric Depression Scale scores >11; Yesavage & Sheikh, 1986), moderate to severe neurological impairments (e.g., traumatic brain injury), recent stroke (defined as in the past year), neurodegenerative disorder (e.g., Parkinson's disease or Alzheimer's disease), history of a psychotic disorder, or physical conditions that precluded sitting or playing a recorder were excluded. Enrolled participants were eligible to receive two gift cards to a local supermarket worth a total value of $50 for completing the two assessment visits.

Overview of Study Design

Participants were screened for eligibility and underwent informed consent procedures approved by the University of Maine Institutional Review Board. Enrolled participants completed two in-person assessments at Time 1 (T1: preintervention) and Time 2 (T2: postintervention). The MUSIC Project provided 12 recorder lessons of 1 hr each to music-naïve older adults in a group format.

Groups ranged from six to 10 people in size. Participants were provided with all necessary materials for the music lessons. Weekly lessons were led by trained music instructors. Feedback regarding the participants and instructors experience with the lesson plans was collected each week and a comprehensive survey was collected at T2.

MUSIC intervention. The MUSIC Project is an interdisciplinary collaboration between Philip Edelman (doctorate, music education) and Rebecca MacAulay (doctorate, a clinical psychologist with expertise in cognitive aging). The MUSIC Project's instructor and learner manuals were designed to address the cognitive, physical and motivational challenges in music learning based on behavioral observations and participant feedback (see Table 2 in Results for details). The manuals provide 12 lessons with homework assignments specifically designed to teach music to older adults.

The primary learning objectives for the 12 sessions are available as online supplemental materials. Each group session was approximately 45-min with 15-min allowed for questions and feedback. Each session's chapter provides vignettes to describe the learning objectives and musical literacy skills using nontechnical jargon whenever possible. New music terminology and notations are highlighted in yellow and defined within each chapter and are summarized in the review section at the end of the chapter. Additionally, finger placement and notation charts are provided. Psychoeducational vignettes include motivational stories to normalize the challenge of learning to play a musical instrument, discussing the role of repetition and practice in developing motor memory, providing information on cognitive aging, arthritis, and hand stretch exercises to help with arthritis pain. Each chapter provides a homework assignment to reinforce the skills learned within that session. Participants are told, "Practice is a way of introducing growth into our life" and provided psychoeducation on the benefits of regular practice. They are then instructed to select specific times that they will practice and write them down on their weekly schedule provided within their manuals.

The MUSIC Instructor manual mirrors the learner manual but also provides teaching tip boxes highlighted in orange and the homework answer key for every lesson. Teaching tips include suggestions to address common learning challenges, improve skill reinforcement, clarify instructions, and use of practical examples to illustrate musical concepts (e.g., playing lower notes require slower air such as when you fog up a mirror with your breath). Homework assignments are reviewed with the music group members at the beginning of each session the following week. Music instructors are advanced undergraduate research assistants from the School of Performing Arts trained by Philip Edelman. The MUSIC instructor and learner manuals with outcome assessment measures are available for use upon request to the primary investigator (R. K. MacAulay).

Assessment measures. The North American Adult Reading Test (NAART) was administered as an estimate of intelligence (Blair & Spreen, 1989) at T1. North American Adult Reading Test estimated full-scale IQ standardized scores are based on the number of correctly read words and is adjusted for age and education norms of the sample. The neuropsychological battery of the Uniform Data Set Version 3 (UDSNB 3.0) evaluated cognitive function at T1 and T2. The UDSNB 3.0 battery provides reliable measures of episodic memory, processing speed, executive function, language, and constructional ability (Weintraub et al., 2009, 2018); specific subtests are listed below. The MoCA served as a measure of global cognition. The semistructured UDS-V3 clinical interview collected relevant mental and physical health information at T1. An objective learning outcome assessment measure designed to evaluate musical literacy and the participants' learning of the lessons' objectives was introduced in Wave 2 and administered at the end of the last session. Secondary study measures (e.g., affective traits and physical function) collected are not reported here.

A comprehensive survey with two parts was adapted from a study investigating perceived benefits of concert band participation among older adults (Jutras, 2011). The survey collected objective and qualitative feedback about their experience with the music group during T2. The first part was a questionnaire using a 5-point Likert scale. For the first part, participants were provided a visual analogue scale and instructed:

> Please read each sentence and select the answer that best applies about your experience of participating in the musical group by selecting how much you agree with the following statements. Rate on a scale of 1 to 5 by putting the number that best applies to the statement in the box next to it. Remember that there are no "right" or "wrong" answers; your truthful answers will help us to learn about your experience. For example, if you do not agree at all with the statement, select "1," which indicates *not at all*; a "5" indicates that you agree *very much*.

Example questions include "The music group increased my self-esteem," "The music group provided valuable opportunities for socialization," and "The music group improved my understanding of music theory." The second part of the survey provided two prompts that participants could freely respond to: "Please list the three most important benefits you feel you received from the music group in order of their importance" and "Please use this section to write any suggestions, comments, or thoughts that you have about your participation in the group."

Data analyses. Neuropsychological test data was first visually inspected for skew and kurtosis. Three participants had unrelated medical events during the course of the study ($n = 3$: hospitalized for a coronary heart event, recovering from eye surgery for glaucoma, and macular pucker with moderate vision loss) that interfered with their testing performance. These participants that were identified as extreme outliers on the neuropsychological tests were removed from this part of the analyses. To reduce the number of comparisons, executive attention (Trail Making Test: Trails A and B), episodic memory (Craft Story 21 Recall immediate and delayed memory), verbal fluency (phonemic and category word fluency tests), and working memory (Number Span Tests) composite average scores were formed from the UDSNB 3.0 neuropsychological battery. Appropriate nonparametric tests were used for non-normally distributed data. TMT raw scores were Winsorized and converted to z scores to place on a similar scale prior to forming the composite measure. Repeated-measure analyses of variance and Wilcoxon signed-ranks test examined the pre- and postintervention neuropsychological composite scores. Partial eta squared and the standardized test statistic Z by the square root of the number of pairs ($r = Z/\sqrt{N}$) served as measures of effect sizes.

Results

Participants

One of our objectives was to use CBPR to enhance the recruitment and participation of more diverse older adults in health research. Forty-one older adults with a mean age of 70 ($SD = 5.12$, range = 59–81 years old) enrolled within the study. Participants had a broad range of education (10–20 years, $M = 15.17$, $SD = 2.78$) but were primarily White women (97.6%). Approximately 63% of the older adults were defined as economically insecure (<$20,000). The median family income was $17, 000 ($M = 29,098$, $SD = 19,156$; range = 10,000 to >70,000). All participants were living independently but demonstrated a range in cognitive function on a cognitive screener (MoCA range = 19–29, $Mdn = 26$, $SD = 2.36$), from the normal to mild cognitive impairment range. Participants estimated full-scale IQ (109.03; $SD = 7.81$) fell within the average to superior range (93.40–121.56). Baseline clinical characteristics are summarized in Table 1.

Program Evaluation

Of the 41 enrolled participants, 35 older adults completed the study. Reasons for attrition included unrelated serious medical events ($n = 3$), relocation due to death of husband ($n = 1$), and other attrition reasons ($n = 2$). The highest attrition ($n = 5$ of 16 participants) occurred during the first 3 weeks of the first study wave. For the second study wave of the project our attrition rate decreased to 4% ($n = 1$ of 25). There was an overall attendance rate of 90%. The learning assessment measure introduced in Wave 2 indicated good learning of the material covered in lesson plans ($M = 86.7$ out of 100, $SD = 7.03$, $n = 21$).

The first research question was, "Is it feasible to teach music-naïve older adults how to read music and play a recorder using traditional teaching methods?" Weekly lesson plans initially used a traditional introductory recorder book designed for new music learners; however, within the first two weeks of the study during our program evaluation meetings, we qualitatively identified significant barriers that the older adult participants encountered in learning to read music and play a recorder using these traditional teaching approaches. We thus dispensed of the well-recognized beginner manual after the second lesson during the first study wave. The MUSIC Project's learner and instructor manuals applied the solicited CBPR participant and instructor feedback into the development of its 12 lesson plans, which were specifically designed to reduce the cognitive load of new skill learning within the sessions.

The MUSIC manual's lesson plans continued to evolve through evaluation of the strengths and weakness of each lesson based on behavioral observations, participant feedback via survey and post-study interviews, and objective measurement of the learning goals. A lesson plan evaluation form was completed by the music instructors at each session and reviewed in the weekly program evaluation meetings (see the online supplemental materials). Notable recommendations and changes made to the program and its manuals were both instructor- and participant-based (e.g., the suggestions to use more familiar tunes and the need to reduce jargon and decrease information on pages was provided by participants within the second lesson of the first study wave). Table 2 lists the problems with solutions used to address the observed cognitive, physical, and motivational challenges in music learning. These findings were integrated into the development of the novel MUSIC instructor and learner manuals.

Table 1
Clinical Characteristics Collected at Baseline

Characteristics	% or *M* (*SD*)
MoCA % below score of 26, $n = 26$	43.9
Heart disease	29.0
Hypertension	36.6
Diabetes	14.6
Hypercholesterolemia	41.5
History of stroke or transient ischemic attack	19.5
History of depression (lifetime episode)	39.0
Active depression (currently being treated)	7.3
Geriatric depression scale (range = 0–6)	1.46 (1.76)
Substance abuse history (alcohol)	14.6
Obstructive sleep apnea	19.5
Arthritis	63.4
Thyroid disorder	19.5

Note. MoCA = Montreal Cognitive Assessment. $N = 41$ unless otherwise noted for the MoCA.

Program Outcomes

Cognitive measures. Descriptive statistics for the neuropsychological test scores that formed the composite measures at T1 and T2 are presented in Table 3. Repeated measures adjusting for education indicated that executive attention/processing speed improved from T1 to T2, $F(1, 30) = 5.14$, $p = .031$, $\eta_p^2 = .146$. Trend level improvements in working memory from T1 to T2 were found, $F(1, 31) = 3.50$, $p = .071$, $\eta_p^2 = .102$. Changes in episodic memory performance from T1 to T2 were not statistically significant, $F(1, 31) = .347$, $p = .560$, $\eta_p^2 = .011$. Wilcoxon signed-ranks test indicated statistically significant changes in global cognition, verbal fluency, and visual memory performance following the 12-week music intervention. Specifically, MoCA scores were higher at T2 as compared to T1, $Z = 2.159$, $p = .031$, $r = .471$. Phonemic fluency significantly improved at T2 as compared to T1, $Z = 3.186$, $p = .001$, $r = .560$; whereas, category fluency did not demonstrate a significant change, $Z = 1.092$, $p = .275$, $r = .193$. Delayed visual memory performance measured by the Benson figure copy demonstrated an improvement at T2 as compared to T1, $Z = 1.999$, $p = .046$, $r = .353$.

Table 4 presents the subjective ratings from the survey that inquired "how much the music group improved" cognition or provided mental stimulation. Over 96% of the participants reported that the music group improved concentration, motor coordination, and memory. All participants reported being mentally challenged by the group, ranging from "a little" to "very much."

Social and emotional well-being measures. Table 5 presents the subjective ratings from the survey that inquired "how much the music group" provided or improved self-esteem, social, and/or emotional well-being. Nearly all of the participants reported that participating in the music group provided "camaraderie" and "valuable socialization." Similarly, the majority of participants reported that participating in the music group increased their

Table 2
Qualitative Data Based on Participant Feedback and Instructor Observations

Learning challenge	Solution(s)
Difficulty visually tracking	Increase use of white space and font sizes (14–18 point)
Difficulty recalling notes and music literacy concepts	Reduce the sequential processing demands by reordering and breaking skills down into discrete learning units
	Provide adequate reinforcement of learning by greater use of repetition to build skills
	Practice motor memory exercises for finger positions
	Reduce technical jargon
	Provide more practical/applied examples
	Include homework assignments with reviews each session
	Use familiar songs (e.g., "Mary Had a Little Lamb") to improve sound recognition
Frustration/Discouragement	Provide psychoeducation and motivational vignettes to normalize learning challenges
	Regularly acknowledge skills acquired
	Learning familiar songs proved to be reinforcing
Arthritis complaints	Provide psychoeducation with supplementary hand exercises

self-esteem and self-confidence and provided them with a sense of accomplishment. Additionally, over 90% of participants reported that the music group reduced stress and improved emotional well-being.

During the program evaluation, some important themes emerged. The survey data indicated that participants universally reported "learning" and social engagement and support among the top three benefits of participating in the group. Another theme was self-criticism and negative evaluation of oneself (e.g., "I am slow . . . this is frustrating, I should know how to do this"). Psychoeducational and motivational vignettes with group discussions were thus integrated into the lesson plans to address this learning challenge. We perceive that the instructors' use of reinforcement (e.g., highlighting what they have learned so far and abundant praise) was a critical component to the intervention's positive outcomes. Other notable themes included feelings of pride and accomplishment (e.g., "I felt proud to remember the concepts") and camaraderie.

Table 3
Neuropsychological Test Scores That Formed the Composite Measures

Neuropsychological test	Time 1, *M* (*SD*)	Time 2, *M* (*SD*)
Executive attention		
Trail Making Test–Trail A[a]	36.25 (9.99)	33.27 (10.57)
Trail Making Test–Trail B[a]	86.14 (27.82)	84.31 (30.25)
Working memory		
Number Span forward total	8.19 (2.31)	8.44 (2.51)
Number Span backward total	6.66 (1.79)	7.22 (1.98)
Episodic memory		
Craft 21 immediate story recall	18.41 (6.31)	18.72 (6.46)
Craft 21 delayed story recall	15.50 (6.32)	16.06 (6.39)
Montreal Cognitive Assessment[b], $n = 26$	25.69 (2.36)	26.23 (2.05)
Category fluency (animal–vegetable)	33.72 (6.92)	35.00 (6.32)
Phonemic fluency (F–A)	25.31 (7.92)	27.81 (7.17)
Visual memory (Benson figure copy)	10.50 (2.59)	11.59 (2.88)

Note. $N = 32$.
[a] Transformed scores due to significant skew and/or kurtosis. [b] Difference in the *n* reflects administrative error at Time 2.

Discussion

The MUSIC Project investigated music training in an economical group format in community dwelling older adults to improve understanding of the relationship between cognitive functioning and psychological well-being with music. Our aim was to apply knowledge gained through CBPR approaches to the development of a music program designed specifically to teach music to older adult learners. Our preliminary findings, methodology, and challenges with solutions encountered during implementation of a music program for older adults are now discussed.

The present study extends primarily correlational findings by investigating whether providing music training to music naïve older adults associated with social and cognitive function. To our knowledge, this is the first study to investigate music training using a recorder in an economical group format in music naïve older adults. Consistent with our primary hypotheses, our preliminary findings indicate improvements in global cognition and measures associated with frontal lobe function following the music learning intervention. Subjective ratings of improvements in cognition and motor function were also found. Psychologically, participants universally reported improvements in self-esteem, stress and emotional well-being. Further, the recorder training group format used in this study was not only economical, but participants also reported that the group increased socialization and provided a supportive learning environment and a strong sense of accomplishment.

Our first objective was to evaluate the feasibility of providing music training using a recorder. It is important to note that most if

Table 4
Percentage Ratings of Degree of Subjective Cognitive and Mental Stimulation Benefits

Rating	Improved concentration	Improved motor coordination	Improved memory	Challenged me
Not at all	2.9	5.9	2.9	0
A little	5.7	8.8	17.6	3.0
Some	31.4	29.4	26.5	6.1
Quite a bit	37.1	29.4	38.2	39.4
Very much	22.9	26.5	14.7	51.5

Note. Values presented as percentages.

Table 5
Percentage Ratings of Subjective Improvements in Emotional and Social Well-Being

Variable	Not at all (%)	A little (%)	Some (%)	Quite a bit (%)	Very much (%)
Accomplishment	0	5.7	11.4	42.9	40
Self-esteem	11.4	11.4	31.4	28.6	17.1
Self-confidence	5.9	23.5	14.7	41.2	14.7
Camaraderie	5.9	8.8	29.4	29.4	26.5
Reduced stress	2.9	5.7	31.4	37.1	22.9
Valuable socialization	0	5.7	40.0	34.3	20.0
Emotional well-being	2.9	14.7	29.4	41.2	11.8

not all music recorder instructional manuals are designed to work with second- to fifth-grade-level learners; thus, age-related differences in learning, vision and brain plasticity may render these teaching methods ineffective for older adult learners. Through the use of CBPR approaches, the MUSIC Project qualitatively identified barriers older adults experienced in learning to play a musical instrument when traditional teaching methods are employed. Cognitively, slower information processing speed and difficulty with working memory and visually tracking the musical notes impacted the participants' ability to remember and play the notes. Physically, participants complained of arthritis and had difficulty with hand placement. Emotionally, participants were initially becoming discouraged and critical of their performance. Thus, based on the knowledge we gained from session observations and participant feedback, the MUSIC Project's instructor and learner manuals were created to overcome these challenges.

The MUSIC Project's manuals were designed to reduce the sequential processing demands and provide adequate reinforcement of learning by use of repetition. We also minimized use of technical jargon by using everyday language and teaching the musical concepts through practical examples. Vision challenges were decreased by use of ample white space and larger font size. Motivational challenges were addressed by providing psychoeducation and activities designed to address potential challenges for older adult music learners. For instance, vignettes were created to normalize the challenge of learning to play a musical instrument, discuss the role of repetition and practice in developing music literacy and motor memory for finger placement, and provide information on cognitive aging and arthritis. Hand stretch exercises for arthritis pain were also introduced based on online educational resources (Mayo Clinic, 2015).

There are several notable strengths to this study. As hypothesized, enhanced performance was found on neuropsychological measures of executive function and attention/processing speed, working memory, and visuospatial function. However, due to the lack of a control group in this study, we cannot determine the extent to which these findings reflect practice effects from repeated testing or more general novelty effects. Here, it is worth noting episodic memory tests tend to be highly susceptible to practice effects (MacAulay et al., 2018), and that there were no significant changes found on these measures. Another strength of this study is the use of CPBR methodology to recruit a diverse older adult sample with a wide range of function to help facilitate the generalizability of the study's findings to populations at greater risk of cognitive decline (Johnson et al., 2018). The majority of cognitive aging studies have favored college educated and higher socioeconomic status sample populations. Within the present study, approximately 63% of the sample was defined as being economically insecure and education level ranged from 10–20 years. Additionally, the presence of medical and mental health conditions were well represented in the sample. There was also a wide range of cognitive function, with MoCA scores falling in the normal to mild cognitive impairment range.

Potential limitations to the study sample are the almost entirely female and white sample. The reason for the sex imbalance is unclear; speculatively, it is possible that women more than men were attracted to the music intervention. As to the racial makeup of the sample, this is reflective of the 94.7% non-Hispanic white population estimate for the state of Maine (U.S. Census Bureau, 2018). Future research will need to extend these findings to men and more ethnically diverse populations.

Music is unique in that it appears to be something that we naturally gravitate toward and to be an activity that can provide therapeutic benefits. Research on music therapy, in particular, has established that music can have a positive effect on anxiety, depression and QoL; however, research has been mixed regarding its effect on disruptive behaviors and whether it provides cognitive benefits in patients with dementia (Raglio, Filippi, Bellandi, & Stramba-Badiale, 2014; van der Steen et al., 2018; Zhang et al., 2017). It is thus important to draw a contrast between the present methodology and music therapy. First, music therapy is provided by individuals with credentialed training in the delivery of music interventions, whereas this study used undergraduate level research assistants as music instructors trained by a music educator to enhance the scalability of the MUSIC intervention. Second, music therapy generally involves assessment of patients in response to an underlying condition and the development of individualized treatment plans to address patient symptoms through four distinct methods (recreation, composition, improvisation, and receptive or listening experiences) as defined by Bruscia (2014). It is possible that some populations, such as those with severe cognitive impairments (e.g., dementia), may benefit from the individualized treatment approach used in music therapy. Within this study, the focus was on the acquisition of music performance knowledge as a means of enhancing social, emotional and cognitive function in community dwelling older adults. Additionally, collaborative learning strategies (e.g., pairing music learners together at varying and/or matched levels of abilities) were used to foster skill acquisition and address individual level differences within the group setting; this didactic approach appeared to have contributed to the qualitative theme of enjoying the camaraderie involved in learning together that emerged during the CBPR

feedback. The above highlighted strengths and limitations to these different approaches should be considered in the implementation of music training for older adults.

In sum, results indicated the MUSIC group training provided an intrinsically reinforcing activity that associated with enhanced cognitive function and relevant measures of personal well-being. Our findings and others support the importance of providing activities that promote socialization and learning for cognitive health. It is also important to address that while certain cognitive-remediation interventions that focus on rote-drilling techniques overall do not appear to be effective, these drilling techniques appear to be important to initial learning of skills. Thus, it appears that tangible skill acquisition paired with cognitive stimulation and an emphasis on learning processes (such as, enhancing music or mathematical abilities) may prove to be an optimal combination for cognitive-remediation interventions (Green & Bavelier, 2008). Future work intends to conduct a randomized clinical trial to determine whether these effects are specific to the music recorder training group or can be extended to gaining knowledge in music literacy through a music listening group. A randomized clinical trial will allow us to evaluate the role of practice effects on the cognitive tests by inclusion of a control group. We also intend to examine additional important psychosocial variables' (e.g., QoL and mood) relationship with music training compared to music listening conditions.

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