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An Interprofessional Study of the Effect of Music as a Non-Pharmacological Intervention on the ABC's (Affect-Behavior-Cognition) of Older Adults with Mild or Moderate Dementia

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Abstract:

OBJECTIVE: To observe the impact of individualized music listening via headphones on measures of affect, behavior, and cognition/memory in 19 institutionalized nursing home residents with mild or moderate dementia, as well as to examine whether music listening reduces antipsychotic medication utilization.

DESIGN: A 7-week observational, naturalistic, non-blinded, feasibility study comparing 4 groups (No music x 4 weeks; No music x 2 weeks followed by Music x 2 weeks; Music x 2 weeks followed by No music x 2 weeks, Music x 4 weeks).

SETTING: An extended care facility in Indianapolis, IN.

MEASUREMENTS: We administered the following tests at baseline, after two weeks of music or non-music listening and a week after the music intervention period ended: Geriatric Depression Scale (GDS), Geriatric Anxiety Inventory (GAI), Cohen-Mansfield Agitation Index (CMAI), Mini-Mental State Examination (MMSE), Famous Names Test (FNT), and Hopkins Verbal Learning Test-Revised (HVLT-R). We also assessed changes to scheduled medications related to dementia treatment and to medications known to impact cognitive function to observe the impact of music on medication utilization.

RESULTS: Patients who were enrolled in our study improved in their general cognition and retrospective memory across the seven weeks of our study (although the extent of this improvement did not depend on music listening). The four groups (Music, No Music then Music, Music then No Music, and No Music) displayed different patterns of agitation across the course of our study. We did not document any initiation, discontinuation, or other changes to scheduled medications.

CONCLUSIONS: This study of music listening did not reveal strong evidence of changes in affect, behavior, or cognition, although it did show trends toward such results, particularly for agitation and memory. The small number of research participants may have limited our power to detect real underlying differences between the patients who listened to music and those who did not. Music did not influence medication utilization, including antipsychotic agents, and this is likely because the changes in agitation we observed were not of sufficient intensity or duration to impact medication regimens on such a short-term basis. Additional or persistent decreases in agitation might affect medication regimens over a longer period of time. Importantly, this feasibility study demonstrated that individualized music from patients' late teens and early 20s can be safely utilized with elderly patients with dementia in a nursing home setting and provides a supporting foundation to promote additional research with larger populations over longer intervention periods.

Keywords: *dementia, antipsychotics, memory, behavior, agitation, music listening*

1. INTRODUCTION

According to Alzheimer's Disease International, the worldwide prevalence of Alzheimer's disease and related dementias (ADRD) is predicted to double every 20 years to 65.7 million afflicted by 2030.[1] Despite the existing and anticipated future prevalence, no FDA-approved pharmacologic agents currently exist either to slow the natural progression of ADRD or to treat the acute behavioral and psychological symptoms of dementia (BPSD). Furthermore, existing pharmacologic treatments demonstrate modest to questionable benefit and may also have the potential to cause significant and serious adverse events, including stroke and death.[1,2] Consequently, researchers and clinicians have developed renewed interest in non-pharmacologic approaches to treat BPSD. In particular, emerging evidence suggests that music exposure may elicit a short-term positive impact on affect, behavior, and/or cognition/memory in ADRD.[3-7]

Existing research predominantly evaluates music's effect on behavior (i.e., agitation) more so than on cognition or on psychological symptoms (e.g., anxiety, depression, delusions, hallucinations, insomnia) in patients with any type or severity of dementia.[4,6] For example, Raglio and colleagues randomized 29 participants to a control group who experienced non-musical, interactive care and compared them to 30 participants who underwent ten, 30-minute group music therapy sessions over a 16-week period.[8] Music therapy sessions consisted of playing rhythmic and melodic instruments to accompany musical selections. Participants in the music therapy group demonstrated significantly less agitation, anxiety, delusions, nighttime behavior disturbances, and aberrant motor activity than controls.

Similarly, Gerdner conducted a 14-week crossover trial in which 39 elderly participants with ADRD listened to individualized versus classical music for 30 minutes twice a week.[9] Participants who listened to music individualized to their preference demonstrated significantly greater reductions in agitation than those listening to classical music. The author proposed that music focuses attention, provides an interpretable stimulus, and overrides other meaningless and/or confusing environmental stimuli that can precede anxiety and agitation. The greater benefits associated with individualized rather than classical music may demonstrate the reminiscence effect – the phenomenon that older adults best recognize music to which they were exposed during their late teens to early twenties, recall more facts about music from this sensitive time period, and experience more specific autobiographical memories and stronger emotions in response to this music than to music they experienced at any other time in their life.[10]

Fewer studies to date have investigated the effects of music on affect or cognition in patients with dementia. Bruer et al. studied the effect of music therapy on the general cognitive functioning of 28 dementia patients.[11]Music intervention included 8 weeks of once-weekly, 45-minute listening sessions of popular selections from the time period when participants were about 25 years old. Compared to placebo, there was a significant improvement in cognition as measured by the Mini Mental State Examination (MMSE) for the music therapy group on the day following music therapy but not one week following music exposure. Therefore, music therapy offered an immediate, but transient, cognitive improvement.

Chu and colleagues studied the effect of usual care compared to group music therapy on the cognitive abilities of 104 dementia patients.[12] Participants in the music therapy group met collectively with a music therapist for 30 minutes twice weekly for six weeks. Similar to the Bruer et al. study, patients in the music intervention group exhibited a small improvement in MMSE scores across the six-week trial. Moreover, the music intervention group also exhibited reduced depressive symptoms compared to the control group, suggesting that music therapy may also positively impact affect and mood.[10]

These findings from select, higher quality studies suggest that music exposure in the form of music therapy generally confers positive effects on affect, behavior, and cognition in ADRD. This especially seems to be true when the music intervention includes music that is, at least partially, tailored to the patient's individual tastes and preferences. A meta-analysis by Kverno et al. demonstrated that specific music interventions that involve the presentation of patient-preferred music (HPPM) via headphones decrease agitation while improving affect and cognition, lending further support to the benefits of this non-pharmacological approach to improving the lives of patients with dementia.[13]

Most of the past research has focused specifically on the use of formal music therapy (MT) in patients with ADRD. MT focuses on the role of music elements (singing, listening, improvising, rhythmic

exercise) within an established therapeutic relationship between a patient and a music therapist. MT can be contrasted with more passive music listening (ML), which is more individually based, is less labor and cost intensive in implementation, and does not rely upon a direct relationship between a patient and a therapist.[14-16] Virtually all accumulated evidence in the literature utilizes MT, rather than ML, as the basis for improving BPSD. Therefore, studies evaluating the utility of ML on BPSD are needed. Only one known small (N=17) crossover study has evaluated the role of individualized ML, compared to MT offered by a music therapist, for improving the quality of life of patients with moderate to severe dementia.[15] Participants received 30 individual biweekly music sessions lasting 30 minutes each. Participants experienced either MT or ML for 15 sessions, followed by a 2-month washout period before they received the other type of intervention (MT or ML) for 15 sessions. While there were no statistically significant differences between ML and MT for any outcome measure (i.e., NeuroPsychiatric Inventory score, agitation, depression, anxiety, or irritability), agitation and BPSD scores improved in both groups. Therefore, this one small study suggests that ML may offer benefits on par with MT to patients with ADRD.

Due to the accumulated evidence regarding the effectiveness of MT and the possible benefits of ML (coupled with a paucity of data on its use and effectiveness), our interprofessional team of academic and clinical researchers sought to conduct the first feasibility study to evaluate the utility (safety and effectiveness) of individualized ML in the form of HPPM in institutionalized patients with ADRD. Our first primary objective was to observe the impact of HPPM on BPSD (i.e., affect, behavior (including agitation), and cognition/memory) for patients with mild or moderate dementia residing in a nursing home facility. However, we also wanted to expand on past research by examining other potential benefits of HPPM. Thus, the second primary objective of our study was to examine whether regular HPPM sessions reduce antipsychotic medication utilization in nursing home residents with ADRD. While the current standard of care for agitation management includes typical and atypical antipsychotics, the use of these agents may result in extrapyramidal motor deficits, weight gain, increased stroke risk, and increased mortality in elderly patients with dementia (listed as a black box warning for antipsychotics).[1,2, 18-20] Given the current nationwide effort to minimize psychotropic use in vulnerable, institutionalized persons, individualized ML therapy could provide an alternate approach to treating agitation in patients with dementia resulting in substantial reductions in both institutional medication costs and the psychotropic side effects experienced by patients, thereby improving the quality of life of both patients and their caregivers.

2. MATERIALS & METHODS

Procedure

The music intervention (HPPM) was part of an observational, naturalistic, non-blinded, control group feasibility study. Study participants resided within an Indianapolis, Indiana nursing home. The study was reviewed and approved by our Institutional Review Board before we contacted the facility director to review study objectives and protocol. Participant inclusion criteria consisted of a Folstein Mini-Mental Status Examination score of 21 to 26 (mild dementia) or 10 to 20 (moderate dementia). All participants were primary English speakers. Nursing home staff approached the residents who met inclusion criteria, explained the protocol, and obtained consent. For participants with a healthcare proxy, the proxy was able to choose to consent or to decline on the resident's behalf.

The study began with a two-week, usual care run-in phase to establish each participant's baseline (Weeks 1-2). The trial duration was predetermined to last for a total of four weeks (Weeks 3-6) following the run-in phase, with a subsequent seventh week to evaluate post-trial effects. Patients were randomized to one of four treatment groups: music intervention all four weeks (Music Group); music intervention during weeks 3 and 4 followed by no music during weeks 5 and 6 (Music then No Music Group); no music during weeks 3 and 4 followed by music during weeks 5 and 6 (No Music then Music Group); and no music intervention throughout the study duration (No Music Group) as presented in Table 1.

We provided the participants who were randomized to one of the three HPPM groups an iPod shuffle to listen to pre-selected music for 30 minutes during routine sessions on Monday, Wednesday, and Friday of the trial's intervention weeks. Both enrolled residents and their family members provided input regarding personal music preferences from the residents' late teens and early 20s (ages 14 to

25). Based on this input, we created an individualized playlist used during the resident's scheduled music listening sessions.

Table 1. *Study Design*

Group	Baseline Run-In Phase	Intervention Phase		Final Assessment Phase
	Weeks 1-2	Weeks 3-4	Weeks 5-6	Week 7
Music Group	Each Participant Underwent Baseline Assessment	Music and End of Week 4 Assessment	Music	Each Participant Underwent Post-Intervention Assessment
Music Then No Music Group		Music and End of Week 4 Assessment	No Music	
No Music Then Music Group		No Music, but End of Week 4 Assessment	Music	
No Music Group		No Music, but End of Week 4 Assessment	No Music	

We evaluated participants' affect, behavior, and cognition/memory at baseline, after each week of the intervention phase of the study (Weeks 3-6), and a week after the intervention phase ended (Week 7). These assessments included measures of Affect (depression and anxiety), Behavior (agitation) and Cognition (global cognition, retrospective memory and recent episodic memory). In order to focus our analyses and to reduce the impact of missing data on our results, we analyzed data from only three time points: Baseline, End of Week 4 (at the completion of the first phase of intervention) and Week 7 (Posttest).

Additionally, we reviewed participant medical records in detail to record any changes across the duration of the study in scheduled medications related to dementia treatment or medications known to impact cognitive function. These medications included acetylcholinesterase inhibitors (donepezil and rivastigmine), memantine, anticholinergics (dicyclomine, oxybutynin, benztropine, trihexyphenidyl), antidepressants (tricyclic antidepressants [TCAs], selective serotonin reuptake inhibitors [SSRIs], serotonin norepinephrine reuptake inhibitors [SNRIs]), as well as typical and atypical antipsychotics. Medication data was reviewed at baseline during the two-week run-in phase, the last day of each week during the 4-week trial phase, and the last day of the week in the one-week post-trial phase.

Materials

Geriatric Depression Scale (GDS)[21]. The 30-item Geriatric Depression Scale required participants to answer "Yes" or "No" to questions about depressive symptomatology. This included questions like; "Do you feel your life is empty?" "Do you feel your situation is hopeless?" and "Do you prefer to stay home rather than go out and do new things?" Possible scores on this measure ranged from 0 to 30 with higher scores indicating a greater degree of depressive symptomatology.

Geriatric Anxiety Inventory (GAI)[22]. The Geriatric Anxiety Inventory included 20 items. Each described a typical symptom of anxiety, such as "I worry a lot of the time," "I often feel shaky inside," and "Little things bother me a lot." Participants marked "Agree" or "Disagree" for each item. Possible scores ranged from 0 to 20; higher scores reflected greater anxiety.

Cohen-Mansfield Agitation Inventory-Short Form (CMAI)[23]. On the CMAI, nursing home staff rated each resident's level of agitation by indicating the frequency of 14 different sets of behaviors on a scale from 1 = "Never" to 5 = "A few times an hour or continuous for half an hour or more." Example behavior sets included: "hitting, kicking, pushing, biting, scratching or aggressive spitting," "pace, aimless wandering, trying to get to a different place (out of the room, building)" and "general restlessness, performing repetitious mannerisms, tapping, strange movements." Possible total scores on the CMAI ranged from 14 to 70 with higher scores indicating greater levels of agitation.

Mini Mental State Examination (MMSE)[24]. The 30-item MMSE, a standardized cognitive screening measure used to document the presence and severity of dementia, evaluated orientation to time and place, learning and memory, attention and concentration, naming, verbal repetition, auditory comprehension, reading, writing, and drawing. Possible total scores on this test ranged from 0 to 30, with lower scores reflecting more severe cognitive impairment.

Famous Names Test (FNT)[25]. We created a Famous Names Test to evaluate remote and recent retrospective memory. To create each form of the FNT, we randomly selected five names of individuals famous in the 1950s (old names), five names of individuals famous in the 1990s (new names), and five foil names (foils) from the list provided by Douville and colleagues. [25] We used a different form of the test at each assessment point to minimize carry over effects across evaluations. Each of the 15 names associated with each form of the test was printed on a piece of paper in a random, but fixed, order. We read the names aloud and asked residents to circle those they believed to be famous. We scored the number of old names correctly identified as famous, the number of new names correctly identified as famous, and the number of foils correctly identified as non-famous. Scores on each FNT subscale (old names, new names, foils) could range from 0 to 5.

Hopkins Verbal Learning Test-Revised (HVLT-R)[26]. We selected the standardized HVLT-R as a measure of auditory learning and recent episodic memory so that we could utilize different, but equivalent, forms of this test, one at each assessment time point. On each form of the HVLT-R, the experimenter read a list of 12 categorizable words aloud. The words on each form of the test varied to minimize practice effects across repeated assessments. During the initial learning trials, residents heard the list of words three times, with an opportunity to recall the words after each reading of the list. The total number of words correctly recalled on each of these trials was summed into a learning score with a possible range of 0 to 36 words recalled. Following a 20 minute delay, we again asked residents to freely recall the word list. Scores for delayed recall could range from 0 to 12 words. Immediately following the delayed recall trial, we administered a forced choice recognition test in which residents responded "yes" or "no" to 12 target words intermixed with 12 distractors. A discrimination score (true positives – false positives), with a possible score range of 0 to 12, corrected for response bias when evaluating residents' recognition of the word lists.

3. RESULTS

ABCs

To evaluate the effect of HPPM three times a week on the affect, behavior and cognition/memory of nursing home residents with dementia, we ran a series of 4 (group: Music, Music then No Music, No Music then Music, and No Music) x 3 (time of test: baseline, after two weeks of intervention, posttest) mixed model ANOVAs. Data from all three time points was available for 11 participants for most measures, although we had data from 12 residents for the MMSE and 14 residents for the CMAI. We used Wilks' Lambda multivariate *F*-values to determine statistical significance in order to control for possible violations of the homogeneity of treatment difference variances assumption. Means and standard deviations for each outcome measure for each group at each assessment are summarized in Table 2, and the results of the mixed model ANOVAs are summarized in Table 3. As seen in Table 3, no significant effects emerged for affect (GDS depression or GAI anxiety) or for the ability to learn and remember new information (HVLT-R auditory learning or episodic memory).

Table 2. *ABCs of Dementia Means (Standard Deviations) for Each of the Four Intervention Groups at Each Assessment*

Outcome Measure	Music Group			Music then No Music Group			No Music then Music Group			No Music Group		
	Baseline	**Week 4**	**Posttest**	**Baseline**	**Week 4**	**Posttest**	**Baseline**	**Week 4**	**Posttest**	**Baseline**	**Week 4**	**Posttest**
Depression	4.00 (1.41)	3.00 (1.41)	3.50 (0.71)	7.00 (4.00)	10.33 (6.11)	6.33 (4.62)	2.67 (4.62)	4.67 (3.51)	2.33 (1.53)	8.00 (8.66)	8.33 (5.69)	5.00 (3.61)
Anxiety	2.00 (2.83)	0.00 (0.00)	0.00 (0.00)	5.00 (7.00)	4.67 (5.69)	3.67 (4.62)	2.00 (1.73)	1.00 (1.73)	0.67 (1.16)	11.33 (9.87)	9.00 (9.85)	3.67 (3.22)
Behavior/Agitation	19.67 (5.69)	15.67 (0.58)	21.00 (10.44)	16.50 (2.38)	14.25 (0.50)	15.00 (2.00)	14.00 (0.00)	15.67 (1.53)	16.33 (1.16)	14.50 (1.00)	14.75 (1.50)	17.50 (6.35)
Global Cognition	20.50 (3.54)	24.00 (1.41)	25.50 (2.12)	17.50 (5.26)	21.00 (7.53)	20.75 (8.22)	17.33 (5.13)	20.67 (2.52)	21.67 (4.93)	15.00 (5.29)	16.00 (9.54)	14.67 (5.03)
Auditory Learning												
Learning Trial 1	2.00 (1.41)	2.50 (0.71)	3.00 (1.41)	1.33 (1.16)	0.00 (0.00)	1.67 (1.16)	2.67 (1.53)	2.00 (0.00)	2.33 (0.58)	1.67 (2.08)	1.33 (0.58)	1.00 (1.00)
Learning Trial 2	3.50 (0.71)	1.50 (0.71)	3.50 (2.12)	2.33 (2.08)	1.33 (1.16)	2.33 (2.31)	3.00 (1.00)	3.67 (0.58)	3.67 (1.16)	2.33 (1.53)	2.33 (1.53)	1.67 (2.08)
Learning Trial 3	3.50	3.50	4.50	3.33	2.00	3.67	3.67	4.00	4.00	2.00	1.67	2.00

	(2.12)	(2.12)	(3.54)	(1.53)	(0.00)	(2.08)	(1.53)	(1.73)	(1.73)	(2.00)	(1.53)	(1.73)
Episodic Memory	1.50 (2.12)	1.00 (1.41)	3.00 (4.24)	0.33 (0.58)	0.33 (0.58)	0.00 (0.00)	0.33 (0.58)	0.00 (0.00)	0.00 (0.00)	0.33 (0.58)	0.67 (0.58)	0.00 (0.00)
Retrospective Memory												
Old Names	2.50 (2.12)	2.00 (1.41)	2.50 (2.12)	0.67 (1.16)	3.33 (0.58)	2.67 (2.31)	2.00 (1.73)	2.67 (0.58)	3.67 (2.31)	2.00 (1.00)	2.67 (2.08)	4.00 (1.73)
New Names	4.00 (1.41)	2.50 (2.12)	3.00 (1.41)	2.33 (2.52)	2.33 (0.58)	2.33 (2.31)	3.00 (1.00)	4.33 (0.58)	2.67 (0.58)	4.67 (0.58)	4.00 (1.73)	3.33 (2.08)
Foils	4.50 (0.71)	5.00 (0.00)	5.00 (0.00)	3.67 (2.31)	2.67 (1.53)	4.67 (0.58)	4.33 (0.58)	3.00 (1.00)	2.67 (0.58)	4.33 (0.58)	3.33 (1.16)	2.67 (2.31)

Table 3. *Results of the Mixed Model ANOVAs Examining Music's Effect on the ABCs of Dementia*

Outcome Measure	Main Effect of Intervention Group			Main Effect of Time			Group x Time Interaction Effect		
	F	*df*	*P*	*F*	*df*	*p*	*F*	*df*	*p*
Depression (GDS)	.94	3,7	.47	2.06	2,6	.21	0.50	6,12	.80
Anxiety (GAI)	1.34	3,7	.34	2.55	2,6	.16	0.70	6,12	.66
Behavior/Agitation (CMAI)	1.10	3,10	.40	0.98	2,9	.41	2.27	6,18	.08
Global Cognition (MMSE)	0.85	3,8	.51	6.72	2,7	<.05	0.73	6,14	.63
Auditory Learning (HVLT-R)[a]	1.31	3,7	.35	0.91	2,6	.45	0.46	6,12	0.83
Episodic Memory (HVLT-R)	1.42	3,7	.32	0.23	2,6	.80	1.06	6,12	.43
Retrospective Memory (FNT)[b]	0.72	3,7	.57	0.11	2,6	.90	0.86	6,12	.55

[a]For Auditory Learning, Learning Trial (1, 2, or 3) was included as an additional factor in the Mixed Model ANOVA. The main effect of Learning Trial reached significance (F (2,6) =8.90, $p < .05$), but Learning Trial did not interact with Group (F (6,12) = 0.73, $p = .63$ or Time (F (4,4) = 0.30, $p = .87$, nor did the three way interaction reach significance, F (12, 10.75) = .45, $p = .91$.

[b]For the Famous Names Test, type of name (old, new, foil) was included as an additional factor in the Mixed Model ANOVA. The main effect of Type of Name failed to reach significance (F (2,6) = 2.11, $p = .20$). Type of Name did not interact with Group (F (6,12) = 0.87, $p = .54$, but both the interaction of Type of Name with Time (F (4,4) = 12.73, $p < .05$) and the three-way interaction reach significance, F (12, 10.88) = 3.38, $p < .05$.

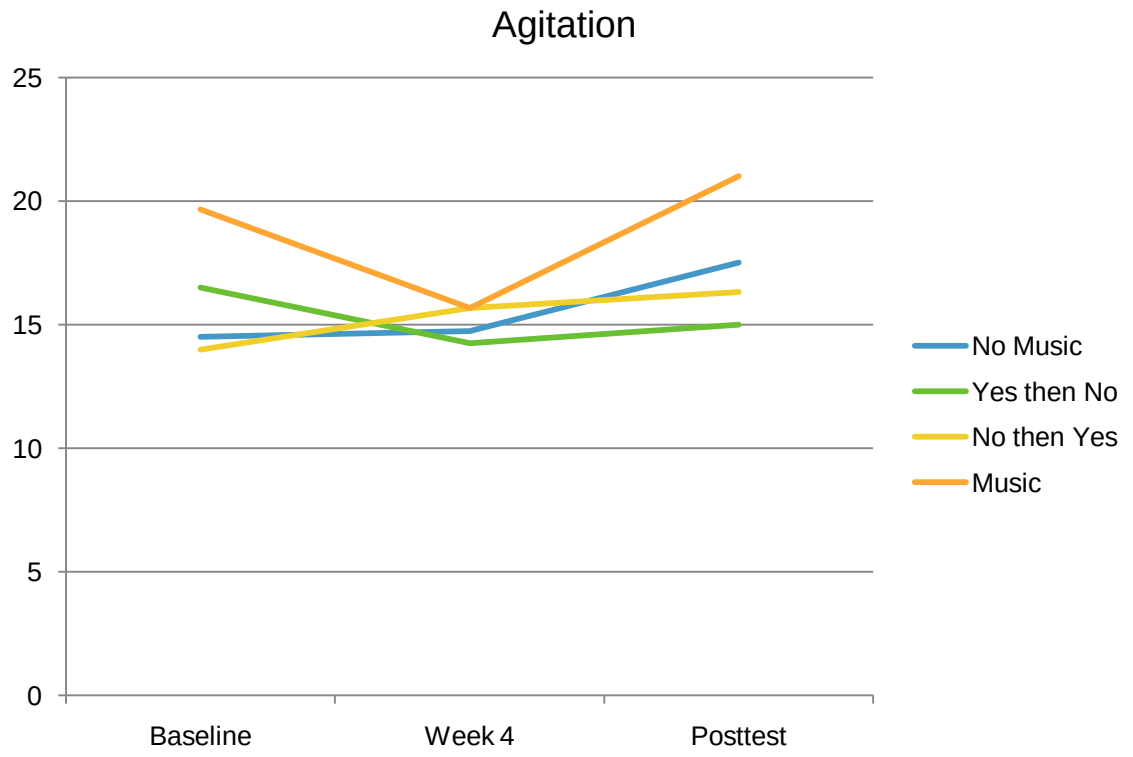

Figure A1. *Agitated Behavior as Rated by Nursing Home Staff for Each Intervention Group at Each Assessment Time Point*

Despite our small sample size, we identified significant or near significant results for several measures. First, we found a near significant Group x Time of Test interaction effect for agitated behavior, F (6, 18) = 2.27, p = .08. As seen in Figure A1, the Music Group got less agitated after two weeks and then got more agitated by the end of the study. The No Music then Music Group got more agitated during the two weeks without music and stabilized with music. The Music then No Music Group got less agitated with music and held steady without, and the No Music Group was fairly stable for the first two weeks, but got more agitated during the duration of the study. However, due to our small sample size, none of these individual group changes reached significance in simple main effect follow-up analyses conducted separately for each group, all ps > .25,

For measures of cognition, the main effect of Time reached significance for global cognitive functioning as assessed by the MMSE, F (2, 7) = 6.72, p < .05. Residents demonstrated a significant improvement in their global cognition across the seven weeks of the study. MMSE scores improved from Baseline (M = 17.33, SD = 4.68) to the end of Week 4 (M = 20.17, SD = 6.41, F (1, 8) = 8.62, p < .05) and then held steady to Posttest, M = 20.25, SD =6.48, F (1, 8) = 0.05, p = .83. This improvement did not vary, however, across the four intervention groups, Group x Time of Test interaction: F (6, 14) = 0.73, p = .63.

For our measure of retrospective memory, the Famous Names Test, we added Item Type (old name, new name, foil) as a within-subjects factor in the analysis. A significant Group x Item Type x Time interaction emerged, F (12, 10.88) = 3.38, p < .05. To further examine this significant interaction, we ran separate Group x Time of Test simple interaction analyses for each type of item. Neither the main effect of Group (F (3, 7) = 0.17, p = .38, the main effect of Time (F (2, 6) = 0.86, p = .47) nor their interaction (F (6, 12) = 1.32, p =.32) reached significance for New Names. For Old Names, the main effect of Time neared significance (F (2, 6) = 4.51, p = .06), but neither the main effect of Group (F (3, 7) = 0.15, p = .93) nor the Group x Time interaction (F (6, 12) = 1.17, p = .38) were significant. Contrast analyses indicated that residents improved in their ability to recognize Old Names from baseline (M = 1.73, SD = 1.42) to the mid-study Week 4 assessment (M = 2.73, SD = 1.19, F (1, 7) = 4.57, p = .07), but did not change significantly from Week 4 to Posttest, M = 3.27, SD = 1.90, F (1, 7) = 1.11, p = .33. A similar pattern of results emerged for residents' ability to recognize Foils, with the main effect of Time nearing significance (F (2, 6) = 4.12, p = .075, but neither the main effect of Group (F (3, 7) = 1.12, p = .40) nor the Group x Time interaction (F (6, 12) = 1.99, p = .15) yielding significant results. However, for Foils, the participants declined in their ability to correctly reject Foil Names from baseline (M = 4.18, SD = 1.17) to the mid-study Week 4 assessment (M = 3.36, SD = 1.29, F (1, 7) = 7.25, p < .05), and did not change significantly from Week 4 to Posttest, M = 3.64, SD = 1.57, F (1, 7) = 0.35, p = .57. Taken together, these results suggest that residents' more distant retrospective memory (memory for old names) improved across the first four weeks of the study, but that this improvement was accompanied by an increased tendency to make false positive identifications of non-famous people on the Famous Names Test.

Changes in ABCs and Participants' Music Background

To determine whether residents' response to music listening depended on their music background, we ran a series of correlational analyses examining the relationships between musical background (number of musical instruments studied, age at acquisition of musical experience, or total number of years of musical experience) and Posttest – Baseline difference scores on each of our outcome measures. We only included participants who listened to music at some point during the study in this analysis (i.e., Music Group, Music then No Music Group and No Music then Music Group, n = 14). Table 4 summarizes these results. Musical background did not significantly relate to changes in depression, agitation or global cognition in response to music listening. A near significant negative correlation emerged between change in anxiety from baseline to posttest and age of acquisition of musical experience (r = -.56, p= .057). Interestingly, an earlier age of acquisition of musical experience was associated with increased anxiety across the course of the study while a later age of acquisition of musical experience corresponded with decreased anxiety from baseline to posttest.

Table 4. *Correlations Between Musical Experience and Changes in the ABCs of Dementia Across the Course of the Study*

	Number of Musical Instruments	Age of Acquisition of Musical Experience	Number of Years of Musical Experience
Baseline to Posttest Change in Depression	-.39	-.24	-.41
Baseline to Posttest Change in Anxiety	.16	-.56	.46
Baseline to Posttest Change in Agitation	.37	.14	.17
Baseline to Posttest Change in Global Cognition	-.04	.00	.16

Pharmacology

Our data did not reveal any significant discontinuation, initiation, or other changes in scheduled medication therapy across the duration of the study. Likewise, no group differences emerged in scheduled medication usage for dementia management. These effects were consistent when analyzing the frequency of medication class orders by week and when specifically examining Alzheimer's and anticholinergic medication usage. Table 5 summarizes the number of patients in each group who were prescribed typical Alzheimer's disease medications and anticholinergic medications. McNemar's test examined changes in each of these medication types from baseline to the end of the study and found no significant differences amongst the four music-listening groups. A related-samples Cochran's Q also indicated that there were no overall significant differences in Alzheimer's disease medications or anticholinergic medications across groups when all time points (Baseline, Week 3, Week 4, Week 5, Week 6 and Post-Test) were compared.

Table 5. *Number of Patients Prescribed Alzheimer's and Anticholinergic Medications*

	No Music Group (n = 5)	No Music Then Music Group (n = 4)	Music Then No Music Group (n = 5)	Music Group (n = 5)	*p*
Mean age (SD)	78.4 (14.8)	79.8 (9.2)	79.4 (5.6)	76.8 (7.2)	.967
Diabetes % (n)	60 (3)	25 (1)	20 (1)	20 (1)	.463
Alzheimer's Medication Use by Week % (n)					
Baseline	60 (3)	50 (2)	20 (1)	0	
Week 4	60 (3)	50 (2)	20 (1)	0	
End	60 (3)	50 (2)	20 (1)	0	ns[a]
Overall					ns[b]
Alzheimer's Medications by Agent % (n)					
None	40 (2)	50 (2)	80 (4)	100 (5)	
Donepezil	20 (1)	25 (1)	20 (1)	0	
Rivastigmine	20 (1)	0	0	0	
Donepezil and Memantine	20 (1)	25 (1)	0	0	
Anticholinergic Med Use by Week % (n)					
Baseline	20 (1)	50 (2)	40 (2)	0	
Week 4	40 (2)	50 (2)	40 (2)	20 (1)	
End	40 (2)	50 (2)	40 (2)	0	ns[a]
Overall					0.129[b]

a = when baseline compared to end using McNemar Test

b = when all sessions compared using related-samples Cochran's Q

4. DISCUSSION

While our study of individualized HPPM and its effect on patients with ADRD did not reveal strong evidence of changes in affect, behavior, or cognition, it did show trends toward such results, particularly for both agitation and memory.The limited number of research participants in this feasibility study, together with missing data from some of those participants, may have limited our power to detect real underlying differences between the patients who listened to music and those who did not. Despite this limitation, we did find that the patients who were enrolled in our study improved

in their general cognition and retrospective memory across the seven weeks of our study (although the extent of this improvement did not depend on music listening). We also found that our four groups (Music, No Music then Music, Music then No Music, and No Music) displayed different patterns of agitation across the course of our study. Although not all of the changes in agitation directly paralleled music listening, the patterns for the No Music then Music group (increased agitation during the no music phase followed by stabilization of agitation during the music phase) and for the Music then No Music group (decreased agitation during the music phase followed by stabilization during the no music phase) did follow our expectations. Thus, our study contributes additional evidence to the literature[15] that ML can positively impact behavior and agitation in patients with ADRD.

Perhaps most importantly, our feasibility study demonstrated that individualized music from patients' late teens and early 20s can be safely utilized with elderly patients with dementia in a nursing home setting. Interestingly, our correlational analyses suggest that musical background may affect the response of patients with ADRD to HPPM. Greater increases in anxiety in our residents with earlier musical experiences relative to those with later musical experiences raises questions never before explored in the literature about whether this type of intervention may be more appropriate for some patients than others. This opens the door to future exploration of individual differences amongst patients with ADRD and how they may not only affect patients' response to this type of intervention but may also impact the types of music that work best for each patient. Regardless, our results contribute to a growing literature regarding the benefits of music for patients with ADRD and suggest that passive HPPM is a safe and positive approach to improving the lives of patients with dementia.

Beyond examining BPSD, our pilot study also assessed changes in scheduled medications used either to manage cognitive decline or to treat agitation in nursing home residents with dementia. Medications did not change for our participants across the 7-week duration of the study. It is likely that the small changes in agitation we observed were not of sufficient intensity or duration to affect medication regimens on such a short-term basis. If the improvements in agitation were to increase or persist with additional HPPM intervention, it might be possible to see resulting medication changes over a longer period of time. Future research studies with HPPM implemented over a more extensive time period and a more continuous longitudinal assessment of medication changes might better assess music's potential to serve as a non-pharmacological, alternative treatment for BPSD.

Another factor to consider in future research involves assessment of "as-needed" (PRN) medications used to treat agitation or other behavioral symptoms of dementia to better evaluate the ability of individualized music listening to decrease reliance on these acute medications. Combining the above aspects with the existing literature on music and dementia and with our desire to perform additional, higher quality interprofessional research, we have recently undertaken a follow-up study to determine whether individualized HPPM can potentially serve as an initial intervention ("music first") or an adjunctive therapy for reducing agitation while improving affect and short-term cognition/memory in ADRD.

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