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Effects of Widespread and Frequent Personalized Music Programming on Agitation and Depression in Assisted Living Facility Residents With Alzheimer-Type Dementia

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Abstract

A music intervention was performed to examine the effects of customized music programming on agitation and depression in a sample of assisted living facility residents (N = 38) with moderate-to-severe dementia. Following a 2-week no-music baseline period, music programs were streamed to the rooms of individuals assigned to a music group (N = 19) several hours per day each day for 12 weeks. Ambulatory residents assigned to the control group were incidentally exposed to the music programming in the course of daily life. Reductions in composite scores on the Cohen-Mansfield Agitation Inventory, Neuropsychiatric Inventory, and Cornell Scale for Depression in Dementia were rapid and sustained in both groups. Creating an almost omnipresent musical atmosphere directed at the musical preferences and listening histories of residents in an assisted living facility may reduce average levels of agitation and depression among the residents.

Keywords

Alzheimer disease, individualized medicine, music medicine, music therapy

Introduction

Among the most significant behavioral and emotional problems confronting patients with dementia and their caregivers are those of agitation, aggression, anxiety, and depression. The potential for music to alleviate such symptoms is gaining considerable attention, though considerable variation in treatment approaches and outcomes has been observed.[1-5]

The most prevalent type of intervention is music therapy, in which there is an explicit focus on the interaction of one or more music therapists with one or more individuals. Group singing of familiar songs is one common example. Both the prescribed music that comes from careful assessment and evaluation as well as direct personal contact are critical elements of music therapy treatment.[4] A second type of intervention, music medicine, can be effective as well, especially when a music therapist is unavailable, such as in the late evening or early morning when patients can be most vulnerable.[6] Music medicine interventions lack the social and psychological aspects of therapeutic intervention that a music therapist typically provides, but music medicine interventions that utilize music playback options have the advantage of lower labor costs and provide the possibility for patients to hear music at times determined to their specific therapeutic need, when staff and therapists may not be available.

Here we examine the efficacy of a music intervention that blends music therapy and music medicine approaches. The intervention is akin to music therapy in that a music therapist designs customized music libraries for each individual based on the individual's music preferences and listening history. These personal factors are an important part of both music therapy and music medicine approaches.[5,7–11] Music programs, adapted for the time of day, are played to the individual's room via speakers several times per day. In this regard, the treatment is more like music medicine.

An important difference between this and previous studies was the amount of music that individuals were exposed to on a daily basis. The range across previous studies spans from relatively little music treatment, for example 15 min/d for 5 days[10]

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Table 1. Participant Summary Information[a]

Treatment	Control	Music
# of participants	19	19
Age, y	81.7 (7.5) [69-97]	80.9 (9.6) [56-93]
Diagnosis		
Alzheimer dementia	14	12
Frontotemporal lobe dementia	1	1
Lewy body dementia	2	2
Vascular dementia	2	2
Early onset Alzheimer dementia	0	2
MMSE (pre)	4.9 (5.4) [0-19]	7.5 (5.8) [0-19]
MMSE (during)	4.2 (5.5) [0-16]	6.5 (5.3) [0-16]
MMSE (post)	4.5 (6.4) [0-19]	6.7 (6.2) [0-19]

[a] Values in parentheses are standard deviations. Values in brackets are ranges. Values for # of participants and diagnosis types are counts, other values are means.

or 20 minutes 1 d/week for 16 weeks,[8] to moderate amounts of treatment, for example 30 to 40 min/d, 2 to 3 d/week for 8 to 12 weeks,[7,11] and thirty 30-minute sessions across 10 weeks.[9] In this study, music was made available to individuals for 3 h/d, 7 d/week for 12 weeks.

Methods

Participants

Thirty-eight participants (25 females) from the Somerford Place Alzheimer's Assisted Living facility in Roseville, California, were enrolled in the study. Potential participants were excluded if they had hearing impairment that was sufficiently severe to impair hearing speech or music played at a moderately loud listening volume. Table 1 provides information about the participants in the treatment and control groups. For individuals from whom it was not possible to obtain direct informed consent, surrogate consent was obtained according to study procedures approved by the author's institution's Institutional Review Board.

Study Design

The study was designed as a controlled, randomized, single-site trial lasting 16 weeks between July and November 2010. Following enrollment of the entire cohort, participants were assigned randomly (using the *randperm* function in MATLAB) into one of 2 groups: a music treatment group (N = 19), and a nontreatment control group (N = 19). Group assignment was completely random, that is, performed without consideration of age, sex, or dementia status.

Timeline

A music therapist performed the assessments necessary to construct an individualized music treatment program for each participant (see Note 1), after which regular behavioral assessments commenced with a 2-week baseline period during which data were collected on all of the dependent measures described below. Following the baseline period, the treatment group received 12 weeks of individualized music programming. Assessments continued during a 2-week posttreatment period in which none of the residents received the music treatment.

Music Intervention

The music delivery system utilized wireless technology to stream music from playlists maintained on a centralized server to a player situated in a participant's room at prescribed times. Music players were placed in every resident's room, and disconnected if the resident had not been assigned to the treatment group.

Individualized programs consisting of commercially available recordings were constructed for each participant irrespective of the group to which he or she had been assigned. In brief ($\sim$30 minutes) interviews with a music therapist, participants were assessed for their music preferences and listening history. Participant responses to brief musical excerpts were noted to establish genre preferences. Further considerations in program design included the participant's age, activities of daily living, and where they grew up, among other variables. Programs were designed to be appropriate for the time of day (arousing in the morning and calming in the evening) by taking into account factors such as tempo, instrumentation, and presence of vocals.

A sample of a customized program played to a resident during the mid-morning time window (9 AM-11 AM) is shown in Table 2. The resident exhibited a positive response to all genres of music except Gospel. He also showed a clear increase in energy and positive affect after being around music for a few minutes. Using this information the music therapist created a prescription intended to aid and support the resident in maintaining energy in the daytime. The goals for the music prescription were identified as (1) decrease in wandering from private residence, (2) increase in long-term memory through reminiscence based on music that was relevant during his prime music memory years, and (3) maintaining current level of cognition.

Music programs were played in each treatment group participant's room 4 times daily within specific time windows adjusted to match the daily rhythms of the individual: 6 AM to 8:30 AM, 9 AM to 11 AM, 2 PM to 4 PM, and 7 PM to 10:30 PM. The first and last programs were 21 to 25 minutes long, and the second and third programs ranged between 50 and 65 minutes. The music selections for any given day's programming were drawn from a large pool of selections deemed appropriate for that individual and therefore did not repeat exactly from day to day. Participants were not required to be in their rooms during the scheduled periods, which meant mainly that ambulatory participants did not necessarily hear all of the mid-morning and mid-afternoon programming.

Dependent Measures

Weekly data samples were collected for the Neuropsychiatric Inventory (NPI),[12] the Cohen-Mansfield Agitation Inventory

Table 2. Sample Customized Mid-Morning Program Presented One Day to a Resident

Title	Composer/Artist
Gloria in D, RV 589: I. Gloria in Excelsis Deo	Vivaldi
In The Mood	Glenn Miller
Symphony No.4 in A, Op.90 (Italian); I Allegro vivace	Mendelssohn
Slavonic Dances, Op. 72—#8 In A Flat	Dvořák
Good Vibrations	The Beach Boys
Violin Concerto In E, Op. 8/1, RV 269, "The Four Seasons (Spring)"—1. Allegro	Vivaldi
Music Goes 'Round and Around	Ella Fitzgerald
Aida—Grand March	Verdi
Good Time	Alan Jackson
Minute Waltz	Chopin
Water Music Suite #2 In D, HWV 349—2. Alla Hornpipe	Handel
Long Train Runnin'	The Doobie Brothers
Brandenburg Concerto no. 2 in F Major, I	Bach
Piano Sonata No. 14 In C Sharp Minor Op. 27 "Moonlight"—Presto Agitato	Beethoven
It Don't Mean a Thing (If It Ain't Got That Swing)	Ella Fitzgerald
Flight of the Bumble Bee	Nikolai Rimsky-Korsakov
La Donna E Mobile	Verdi
Move It On Over	Hank Williams
Serenade in G Major, K. 525 ("Eine Kleine Nachtmusik"): IV. Rondo: Allegro	Mozart

(CMAI),[13] and the Cornell Scale for Depression in Dementia (CSDD).[14] A quick assessment of "sundowning" behavior[15] was performed daily, and a more intensive Mini-Mental State Examination (MMSE),[16] was performed at the beginning, middle, and end of the study period (see "Methods—Dependent Measures" section of text, Supplemental Digital Content 1, for a description of the dependent measures).

Data Collection Strategy and Procedures

Three overarching goals were taken into account when designing the data collection strategy. First, to the extent possible, everyone involved in the data collection process should be blind to the treatment group to which a resident had been assigned. Second, data for each resident should be obtained on a weekly basis. Third, the time of day of the assessments should be taken into account, recognizing that behavioral profiles in the evenings might differ significantly from those during the day. Thus, 2 sets of data were collected for the weekly measures in parallel, once in the early afternoon in interviews with the AM-shift caregivers and once at night with the PM-shift caregivers. To facilitate blinding during data collection, interviewers collected the assessment data in structured interviews with the caregivers. The data were collected using iPads (Apple, Cupertino, California) and forms implemented in *Ensemble*, a Web-based data collection and experiment management system.[17] (See "Methods—Data Collection Strategy and Procedures" section of text, Supplemental Digital Content 1, for a detailed description of the considerations and procedures used to address the three goals listed above.)

Data Analysis

Occasionally, it was not possible for PM caregivers to complete the daily sundowning assessments for all of the residents on a particular day. The rate of missing sundowning data did not exceed 10.5% for any of the residents. Among the weekly assessments, data were missing only for those residents who had to withdraw from the study ($N = 2$) because they left the facility, and in one case 2 weeks of data were missing because of a technical error.

Cumulative scores on each of the dependent measures, that is, the summed score for each instrument for each participant for each shift and each week, were entered into a 3-factor mixed-model analysis of variance (ANOVA) with Treatment (Music, Control) as a between-participant factor and time (weeks 1-16) and shift (AM, PM) as within-participant factors. The model was estimated using PROC MIXED in SAS[18] to accommodate the missing data. The daily Sundowning Severity scores were averaged within shifts for each week and treated as a weekly assessment thereafter. A significant main effect of treatment was predicted, with a reduction of dependent measure scores in the treatment group, a main effect of time, a main effect of shift with lower scores for AM, and a treatment $\times$ time interaction reflecting a reduction of scores in the music group over time relative to the control group. An additional planned contrast (t test) was performed to compare the mean scores during the 2 weeks of baseline assessment (weeks 1-2), with the mean scores during the last 4 weeks of the intervention period (weeks 11-14).

Results

Analyses of age, sex, diagnosis type, and MMSE score distributions showed that the treatment and control groups were closely matched (Table 1). A mixed-model ANOVA of the MMSE scores found no significant difference between groups, $F(1,36) = 1.57$, ns, no significant effect of time point, and no interaction of group and time. The range of MMSE scores in both groups showed that the range of dementia was moderate to severe, but the mean scores were indicative of severe dementia.

Behavioral Measures

Changes in mean composite scale scores for the NPI, CSDD, and CMAI across the study period are shown in Figure 1. Three primary effects are evident in the data. First, the composite scores were lower for the AM observations than for the PM observations. Second, scores decreased during the intervention period relative to the preintervention baseline. Particularly in the case of the AM observations, the reductions in scores were rapid, beginning in the first week of the intervention. Third,

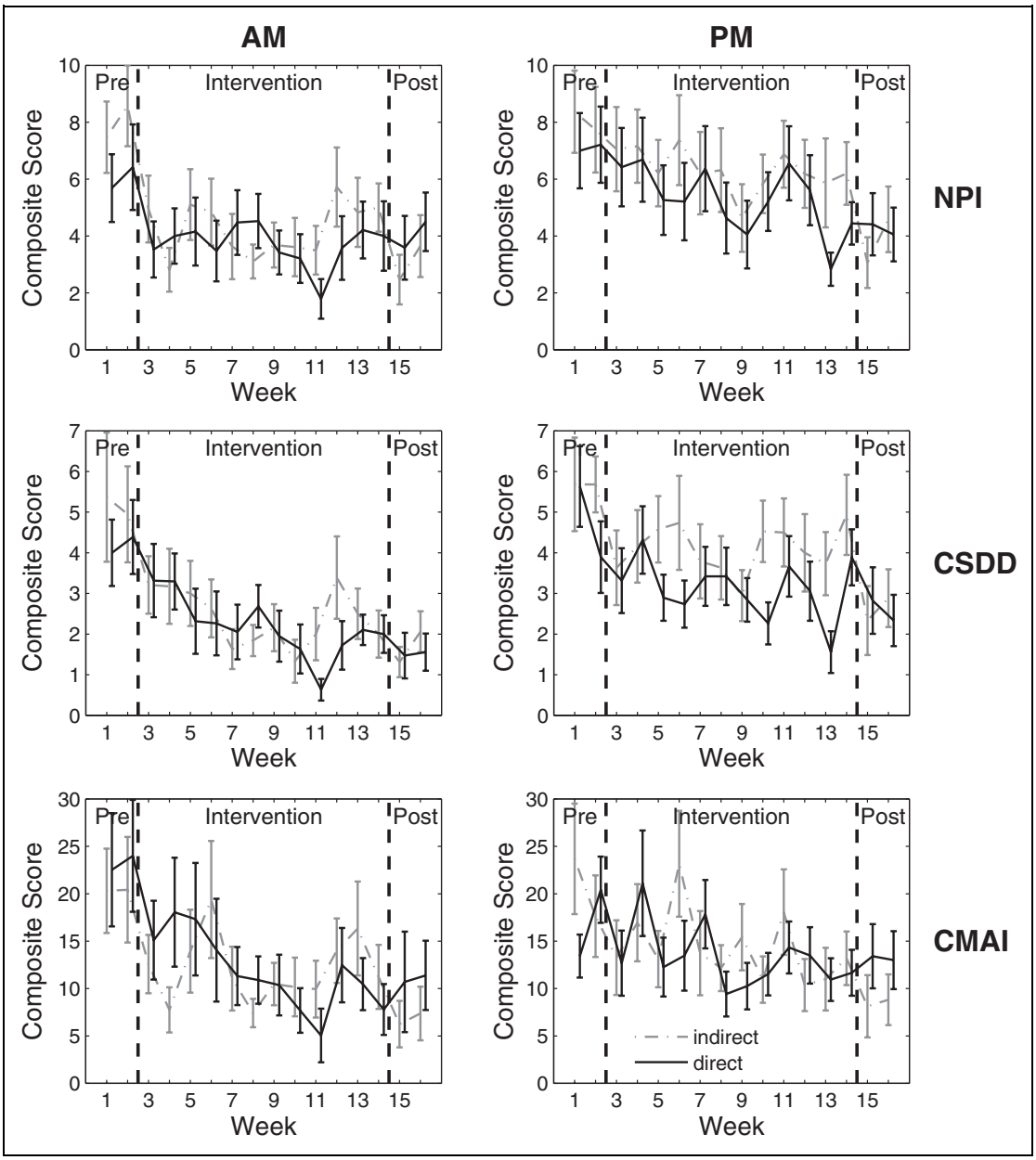

Figure 1. Mean scores on behavioral assessments through time. Top row: Neuropsychiatric Inventory Questionnaire (NPI). Middle row: Cornell Scale for Depression in Dementia (CSDD). Bottom row: Cohen Mansfield Agitation Inventory (CMAI). In each row, the panel on the left shows assessments performed during the AM shift. Solid lines indicate the "direct" group at which music treatment was specifically directed and dashed gray lines the "indirect" group which did not receive intentional music programming. Vertical dashed lines indicate transitions to and from the intervention period during which music was played. Error bars indicate the standard error of the mean.

there were no clear differences between treatment groups in general. That is, those assigned to the control group exhibited reductions in symptom severity that was comparable to those assigned to the music treatment group. As indicated in the Discussion section, the strict distinction between "treatment" and "control" groups was blurred on account of the amount of exposure to music that the control group residents could receive incidentally by wandering around the facility or entering the rooms of residents whose music they liked. Thus, the groups are better characterized as "direct" and "indirect" treatment groups and are referred to as such in the figures.

Main Effects and Interactions

The observations described above were supported by the mixed-model ANOVAs. For the NPI, there was a significant main effect of shift, $F(1, 36) = 38.26$, $P < .0001$; and week, $F(15, 527) = 4.73$, $P < .0001$; but not treatment, $F(1, 36) <$

Table 3. Percentage Reductions in Least Square Mean Estimates of Composite Scores on 3 Behavioral Assessments Collected Both in the Morning (AM Shift) and in the Late Evening (PM Shift)

	AM Shift			PM Shift		
Behavioral Measure	Baseline (Wk 1-2)	Weeks 11-14	Change (%)[a]	Baseline (Wk 1-2)	Weeks 11-14	Change (%)[a]
Neuropsychiatric Inventory	7.04	4.16	−40.87	7.58	5.49	−27.57
Cornell Scale for Depression in Dementia	4.67	2.15	−54.03	5.22	3.69	−29.42
Cohen-Mansfield Agitation Inventory	21.82	11.36	−47.93	18.79	12.67	−32.56

[a] All percentage changes are significant at $P < .0001$

1. There was a trend toward a shift × week interaction, $F(15, 506) = 1.61$, $P < .07$, in which the NPI scores dropped off more slowly in the PM observations. None of the other interactions was significant. Averaged across treatment groups, scores on the NPI decreased substantially between the baseline (weeks 1-2) and late intervention (weeks 11-14) periods both in the morning and in the evening (Table 3).

For the CSDD, there were also significant main effects of shift, $F(1, 36) = 53.91$, $P < .0001$; and week, $F(15, 527) = 6.80$, $P < .0001$; but no effect of treatment, $F(1, 36) = 1.21$, ns. None of the interactions was significant, though there was a trend toward a treatment ×shift interaction, $F(1, 36) = 2.99$, $P < .1$, in which the control group showed less of a decrease in scores during the intervention period than did the music group. A follow-up analysis in which only the data from the weeks of the intervention (weeks 3-14) were considered found the treatment × shift interaction to be significant, $F(1, 36) = 4.30$, $P < .05$, indicating that depression was reduced more in the late afternoon and evening among those specifically receiving the music treatment.

In the case of the CMAI, there was a significant main effect of week, $F(15, 527) = 4.98$, $P < .0001$, though in contrast to the other measures, there was no main effect of shift, $F(1, 36) = 2.01$, ns. There was also no effect of treatment, $F(1, 36) < 1$, though there was a trend toward a treatment × week interaction, $F(15, 527) = 1.54$, $P < .09$. For the related Sundowning severity measure, the main effect of week was significant, $F(15, 528) = 7.53$, $P < .0001$, whereas the main effect of treatment was not, $F(1, 36) = 1.12$, ns. The treatment × week interaction was not significant, $F(15, 528) = 1.49$, ns.

Planned Contrasts

With the exception of the Sundowning severity measure, the results of the more specific contrasts of scores during the preintervention baseline period (weeks 1-2) and the scores during the last 4 weeks of the intervention (weeks 11-14) followed the results of the more general analyses described above (Table 3). Scores were significantly higher during baseline than during the intervention, and none of the treatment × week interactions was significant. Overall, the severity of Sundowning symptoms was significantly greater during the final 4 weeks of intervention than during baseline, $t(528) = -6.99$, $P < .0001$, and the treatment ×week contrast was significant, $t(528) = 3.19$, $P < .002$, due to an increase in symptom severity in the control group but not in the treatment group (Figure 2).

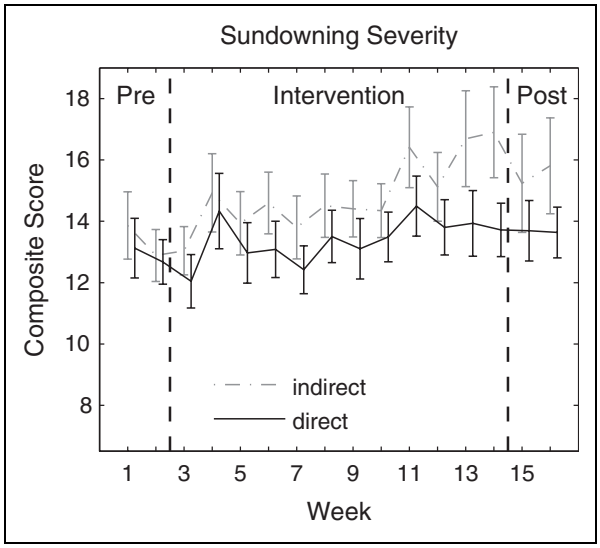

Figure 2. Sundowning severity. Composite scores on an 8-item scale designed for quick assessment of daily sundowning behaviors. The data for each week are averaged across observations made each weekday. Error bars indicate the standard error of the mean.

Individual Variability in Symptom Severity

The standard error bars in Figure 1 indicate that there was considerable variability between participants. In order to examine this individual variability more closely and to examine the effect of the intervention on individuals, we plotted each individual's mean preintervention baseline score (weeks 1-2) against his or her mean score across the intervention period (weeks 3-14). Figure 3 shows that a substantial portion of our sample's composite scores was quite low during both the baseline and intervention periods. The dotted diagonal line in the figure indicates no change between baseline and intervention periods. The preponderance of marks below the dotted diagonal indicates that the intervention period scores decreased for most of the individuals, and this was most evident for those who showed more severe

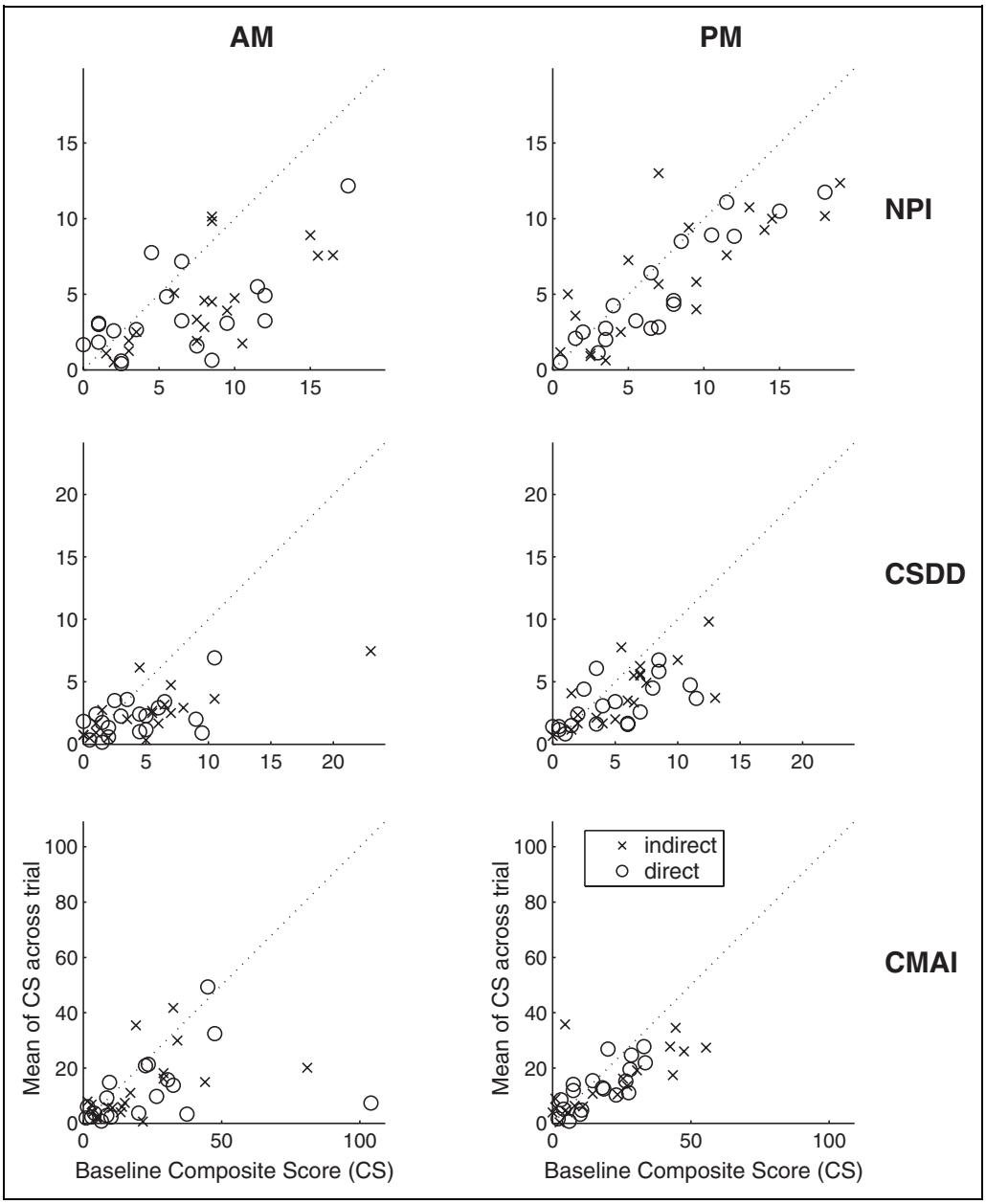

Figure 3. Comparison of individual participant scores during the 2-week preintervention baseline period with average composite scores during the 12-week intervention (trial) period. The dotted diagonal line indicates equivalence of baseline and intervention scores.

symptoms during baseline. These improvements occurred similarly for those assigned to the treatment and control groups.

Caregiver Assessment of Residents

The week following the 16-week study period, caregivers rated the degree to which each resident was influenced by the music program (1 = *insufficient opportunity to observe*, 2 = *not at all*, 3 = *weakly*, 4 = *moderately*, 5 = *strongly*, and 6 = *extremely*). Taking into account only responses of *not at all* and higher, the mean influence on the music group was larger (3.41 $\pm$ 0.15) than that on the nonmusic group (3.05 $\pm$ 0.09). This difference tended toward significance, $t(36) = 2.0009$, $P < .06$. The caregivers themselves were surprisingly blind to the group assignment of the residents. When asked which group a resident had been assigned to, caregivers were unsure 56.3% of the time. When they were sure, they were correct only 61.7% of the time. This fact indicates that music was pervasive throughout the facility and that the distinction between treatment and control groups was blurred in the minds of the caregivers.

Discussion

The objective of this study was to assess the impact of a 12-week music intervention deployed in a single assisted-living residential facility specializing in memory care. It was

hypothesized that those residents who were played customized music programming in their rooms several times per day ($\sim$3 hours/d) every day would show reductions in measures of anxiety, agitation, and depression, whereas those who did not receive music programming would not.

Overall, reductions in symptom severity were observed in both groups (Table 3). The reductions were noticeable shortly after the onset of the music intervention in the facility (Figure 1). Given that the treatment affected both the treatment and control groups, and given the rapid onset of the reduction in several of the behavioral symptoms, several possible confounds must be considered.

Of primary concern were potential bias, practice, and/or burnout effects in the collecting of the data. Several pieces of evidence suggest, however, that a systematic reporting bias did not evolve. One piece of evidence comes from a questionnaire completed by caregivers following the 16-week study period. The questionnaire was designed to gauge their attitudes toward the study, the accuracy of their answers, knowledge about assignment of individual residents to treatment and control groups, and the impact of the music on each resident (see ''Discussion—Caregiver Attitudes and Response Accuracy'' section of text, Supplemental Digital Content 1, for the results of this questionnaire).

Evidence that reductions in symptom severity were not due to systematically biased responding due to imperfect blinding comes from the pattern of results itself. Specifically, symptoms were consistently more severe in the late afternoon and evening than in the morning and early afternoon (Figure 1). Also, the rate of reduction appeared to be faster for the morning NPI than for the morning CSDD, indicative of differential effects of music on particular symptoms rather than a homogeneous reporting bias. Even more importantly, the plots of baseline scores versus mean scores during the intervention period show that not all residents improved over the course of the trial (Figure 3). However, the majority of residents who displayed moderate-to-strong symptoms during the baseline period showed symptom reduction during the treatment period. While these results suggest that there was no systematic reporting bias that caused the reductions in composite scores, the possibility that reduced scores were due to a belief on the part of the caregivers that all residents were receiving the music treatment cannot be ruled out.

Overall Resident Status

In considering the results of this study, it is also important to note that many of the participants exhibited signs of severe dementia based on their MMSE scores, and for many their overall agitation and depression levels and NPI scores were very low (Figure 3). This is in keeping with previous findings that physically nonaggressive and verbal agitation behaviors diminish as the capacity for normal levels of activities of daily living declines.[19] For this reason also, the findings of this study must also be regarded as preliminary in that it remains to be established whether individuals with mild-to-moderate dementia, in whom baseline composite scores would be expected to be higher, would also show the same percentage decreases.

The particular assessments used in this study may not have been the best measure of any potential effects of the music on the most severely impaired individuals. It is conceivable that among very immobile individuals, music will have a beneficial stimulatory effect on motor activity and this could manifest itself in increased scores on measures such as the CMAI or Sundowning severity assessment.

Differences With Previous Music Therapy Studies and Approaches

Amount of music exposure. The music intervention strategy used here differed from that used in previous music therapy studies in 2 significant ways. First, the frequency of music treatment was much greater. Roughly speaking, it is common for the amount of music intervention in music therapy studies to be limited to 1 to 3 sessions per week, lasting under 1 hour. Given the amount of available music, participants were not required to be in their rooms at all times that the music was being played. A number of caregivers remarked that residents were often not in their rooms when the music was playing during the mid-morning and mid-afternoon time windows.

Direct and indirect treatment groups. The second major difference with previous studies was that control group participants could come into contact with the music programming intended for those residents in the music treatment group. Indeed, caregivers reported that ambulatory residents would at times go into other residents' rooms in which music was playing in order to listen to the music. This was an unintentional and unavoidable consequence of the frequency of music delivery, the spatial mixing of the 2 groups throughout the facility due to random group assignment, and the freedom of movement afforded the ambulatory residents of the facility. Consequently, the experimental distinction between the 2 groups of participants became blurred to the point that even the caregivers were uncertain about the group assignment of each participant. For this reason also, the study should not be considered a true randomized controlled trial, and the findings should be regarded as preliminary until a study with control and treatment groups that are completely separated physically is performed.

Interaction of dementia severity and music treatment. Severity of dementia was also greater in this study than in previous studies as indicated by lower MMSE scores.[8,9,11,20] It is currently unclear how dementia severity interacts with music interventions and agitation behaviors. Overall, the effect of music interventions on agitation behaviors remains mixed, with some studies showing reduction of agitation behaviors in moderately–severely demented individuals,[9,20] and another study showing no effect in moderately demented individuals.[11] Our results also indicate that the relationship is complex in that agitation was reduced over the course of the study as

indicated by the CMAI, but agitation manifested in sundowning behaviors actually increased slightly over the course of the intervention. Thus, more detailed examination of the interaction between music, specific agitation behaviors, dementia severity, and time of day is warranted.

Another important consideration for the interaction of music and behavior is the impact of music in the moment. Here we assessed the effects of timed music programs on weekly behavioral trends. However, it is also possible to deliver customized music selections at times of acute need, for example when a resident becomes agitated by a social interaction and needs calming. Such interventions may provide an alternative or additional means of regulating agitation and depression.

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Declaration of Conflicting Interests

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