The Gerontologist
Cite journal as: The Gerontologist Vol. 54, No. 4, 634–650
doi:10.1093/geront/gnt100

Advance Access publication September 5, 2013

Cognitive, Emotional, and Social Benefits of Regular Musical Activities in Early Dementia: Randomized Controlled Study

Teppo Särkämö, PhD, MA,*[,1,2] Mari Tervaniemi, PhD, MA,[1,2] Sari Laitinen, LicPhil,[3] Ava Numminen, PhD, MA,[4] Merja Kurki, PhD, MA,[3] Julene K. Johnson, PhD,[5] and Pekka Rantanen, PhD, MD[6]

[1]Cognitive Brain Research Unit, Institute of Behavioural Sciences, University of Helsinki, Finland.
[2]Finnish Centre of Excellence in Interdisciplinary Music Research, University of Jyväskylä, Finland.
[3]Miina Sillanpää Foundation, Helsinki, Finland.
[4]Unit of Educational Psychology and Department of Teacher Education, University of Helsinki, Finland.
[5]Institute for Health and Aging, Department of Social and Behavioral Sciences and Department of Neurology, University of California, San Francisco.
[6]Käpylä Rehabilitation Centre, Helsinki, Finland.

*Address correspondence to Teppo Särkämö, PhD, MA, Institute of Behavioural Sciences, PO Box 9, University of Helsinki, FI 00014, Finland. E-mail: teppo.sarkamo@helsinki.fi

Received January 17, 2013; Accepted July 24, 2013
Decision Editor: Rachel Pruchno, PhD

Purpose of the Study: During aging, musical activities can help maintain physical and mental health and cognitive abilities, but their rehabilitative use has not been systematically explored in persons with dementia (PWDs). Our aim was to determine the efficacy of a novel music intervention based on coaching the caregivers of PWDs to use either singing or music listening regularly as a part of everyday care. ***Design and Methods:*** Eighty-nine PWD–caregiver dyads were randomized to a 10-week singing coaching group (n = 30), a 10-week music listening coaching group (n = 29), or a usual care control group (n = 30). The coaching sessions consisted primarily of singing/listening familiar songs coupled occasionally with vocal exercises and rhythmic movements (singing group) and reminiscence and discussions (music listening group). In addition, the intervention included regular musical exercises at home. All PWDs underwent an extensive neuropsychological assessment, which included cognitive tests, as well as mood and quality of life (QOL) scales, before and after the intervention period and 6 months later. In addition, the psychological well-being of family members was repeatedly assessed with questionnaires. ***Results:*** Compared with usual care, both singing and music listening improved mood, orientation, and remote episodic memory and to a lesser extent, also attention and executive function and general cognition. Singing also enhanced short-term and working memory and caregiver well-being, whereas music listening had a positive effect on QOL. ***Implications:*** Regular musical leisure activities can have long-term cognitive, emotional, and social benefits in mild/moderate dementia and could therefore be utilized in dementia care and rehabilitation.

Key Words: Alzheimer's disease, Coaching, Cognition, Memory, Depression

Owing to the aging of the population and the rapidly increasing incidence of dementia (Prince & Jackson, 2009), providing sufficient care and rehabilitation for persons with dementia (PWDs) is globally becoming a major challenge for the health care system and the society. Most of the burden of

dementia falls on family caregivers, who provide primary care for over 70% of the PWDs worldwide (Wimo & Prince, 2010) and who are often under substantial burden and psychological distress (Schneider, Murray, Banerjee, & Mann, 1999). In order to alleviate the cognitive, emotional, and social impairments associated with dementia and to reduce the strain of caring for PWDs, many nonpharmacological interventions, such as various multicomponent interventions and cognitive stimulation and training programs, have been developed and shown to be beneficial for improving the behavior, cognition, mood, functioning, and quality of life (QOL) of the PWDs, as well as the well-being of their caregivers (Olazarán et al., 2010). However, as the number of PWDs is increasing and the rehabilitation resources of public health care are becoming more and more limited, it is evident that these interventions can be provided only to a small portion of the PWD population. A viable alternative would be to utilize various cognitively stimulating leisure activities (Hall et al., 2009) that could be used by caregivers regularly to help maintain the cognitive and emotional capacity of the PWD and to ease the burden of his/her care. One such potential leisure activity is music.

Neuroimaging studies have shown that music engages a large-scale bilateral network of temporal, frontal, parietal, cerebellar, and limbic/paralimbic brain areas that are associated with perception of complex acoustic features, such as melody and timbre (Alluri et al., 2012), syntactic and semantic processing (Koelsch & Siebel, 2005), attention and working memory (Janata, Tillmann, & Bharucha, 2002), episodic and semantic memory (Janata, 2009), motor and rhythm processing (Zatorre, Chen, & Penhune, 2007), and experiencing emotions and reward (Koelsch, 2010). Psychologically, music has an important role in emotional self-regulation, communication, and social interaction throughout life, also during aging (Juslin & Sloboda, 2011). Common musical activities, such as music listening and singing, can contribute to positive aging by increasing emotional well-being, maintaining competence, and reducing social isolation (Hays & Minichiello, 2005). In healthy older persons, music listening can temporarily enhance attention and memory (Mammarella, Fairfield, & Cornoldi, 2007; Thompson, Moulin, Hayre, & Jones, 2005), and regular musical hobbies, such as singing and instrument playing, have been associated with better well-being (Cohen et al., 2006) and cognitive functioning (Bugos, Perlstein, McCrae, Brophy, & Bedenbaugh, 2007; Hanna-Pladdy & MacKay, 2011; Kattenstroth, Kolankowska, Kalisch, & Dinse, 2010; Parbery-Clark, Strait, Anderson, Hittner, & Kraus, 2011; Zendel & Alain, 2012), as well as with a reduced risk of developing dementia (Verghese et al., 2003).

In Alzheimer's disease (AD), the ability to perceive music and recognize familiar music and musical emotions remains relatively intact even in the advanced stages of the illness (Cuddy & Duffin, 2005; Johnson et al., 2011). Music can also temporarily reduce anxiety and improve cognitive performance in tasks of verbal and episodic memory (Foster & Valentine, 2001; Irish et al., 2006; Thompson et al., 2005), as well as enhance the encoding and retrieval of verbal information in AD patients (Simmons-Stern, Budson, & Ally, 2010). Based on randomized controlled trials (RCTs), music-based interventions can be effective in alleviating the neuropsychiatric symptoms of dementia, such as agitation, depression, and anxiety (Guétin et al., 2009; Raglio et al., 2008); and also in temporarily enhancing cognitive functioning (Bruer, Spitznagel, & Cloninger, 2007; Hokkanen et al., 2008; Van de Winckel, Feys, De Weerdt, & Dom, 2004). However, most previous studies have focused on relatively short-term and specific therapist-led music interventions targeted for PWDs with moderate–severe dementia and therefore reveal little about the potential long-term benefits of regular musical leisure activities, which would be more widely available for PWDs and their caregivers. Currently, there is some tentative evidence that common musical activities, such as music listening, singing, or dancing, provided by family members and nurses of PWDs may be beneficial in temporarily reducing agitation and anxiety and enhancing positive interaction with the PWD (Clair, 2002; Garland, Beer, Eppingstall, & O'Connor, 2007; Götell, Brown, & Ekman, 2003). However, there is virtually no experimental research about the potential long-term effects of regular leisure- or hobby-based musical activities in PWDs and their caregivers.

The purpose of the present single-blind RCT study was to determine the long-term efficacy of a novel dyadic music intervention based on coaching the family caregivers and nurses of PWDs to use music regularly as a part of everyday care. Specifically, we sought to determine the impact of the intervention on (a) the cognitive functioning of the PWDs, (b) the mood and QOL of the PWDs, and (c) the psychological stress and burden

of the family members of the PWDs. Two types of common musical activities, music listening and singing, which are both highly enjoyable and easily accessible, but which differ regarding their motor and cognitive demand, were contrasted with each other and with usual care. Given the previously reported positive effects musical activities on overall cognitive status (as indicated by the Mini-Mental State Examination [MMSE]; Bruer et al., 2007; Hokkanen et al., 2008; Van de Winckel et al., 2004), executive function and working memory (Bugos et al., 2007; Hanna-Pladdy & MacKay, 2011; Kattenstroth et al., 2010; Mammarella et al., 2007; Parbery-Clark et al., 2011), and autobiographical (episodic) memory (Foster & Valentine, 2001; Irish et al., 2006) in elderly persons, we hypothesized that regular musical activities would enhance cognitive functioning of the PWDs specifically in these domains. Moreover, because singing is cognitively more demanding in terms of short-term and long-term memory associated with verbal learning and retrieval, motor planning/implementation associated with vocal production, and continuous auditory motor mapping and integration associated with monitoring the output and correcting errors (Dalla Bella, Berkowska, & Sowiński, 2011) and engages many prefrontal brain areas, such as the premotor and supplementary motor cortex, dorsolateral prefrontal cortex, inferior frontal gyrus, and anterior cingulate cortex, more than music listening or rest (Brown, Martinez, & Parsons, 2006; Hickok, Buchsbaum, Humphries, & Muftuler, 2003; Kleber, Veit, Birbaumer, Gruzelier, & Lotze, 2010; Perry et al., 1999), we hypothesized that regular singing, in particular, would be effective in enhancing domain-general cognitive functions such as attention, executive function, and working memory. In addition, given the emotional efficacy of receptive (Garland et al., 2007; Irish et al., 2006; Särkämö et al., 2008) and expressive (Guétin et al., 2009; Raglio et al., 2008) music interventions in elderly neurological patients, we expected that both singing and music listening would be beneficial for the mood and QOL of the PWDs. Finally, because singing has been associated with better physical health (e.g., improved heart rate, hormone, and immune functions), emotional well-being, and social functioning in healthy older adults (Cohen et al., 2006; Kreutz, Bongard, Rohrmann, Hodapp, & Grebe, 2004; Skingley & Bungay, 2010), we hypothesized that especially singing would be beneficial for the psychological stress and burden of the participating family members of the PWDs.

Design and Methods

Participants and Study Design

The participants were PWD–caregiver dyads (n = 89) recruited during years 2009–2011 from 5 different day activity centers and inpatient centers in Helsinki and Espoo. The caregivers were family members (n = 59; see Table 1) and nurses (n = 30) of the PWDs. The recruited PWDs met the following inclusion criteria: (a) mild–moderate dementia (Clinical Dementia Rating [CDR] score 0.5–2), (b) no prior severe psychiatric illness or substance abuse, (c) no changes in psychotropic medication during the last 3 months, (d) speak Finnish, and (5) physically and cognitively able to take part in the intervention and undergo the neuropsychological testing. The CDR was performed by the nursing staff upon recruitment. The dementia diagnosis had been made earlier at each center by a geriatrician or a primary care physician, and it followed the Finnish Current Care Guidelines (Working group appointed by the Finnish Medical Society Duodecim, Societas Gerontologica Fennica, the Finnish Neurological Society, Finnish Psychogeriatric Association, and the Finnish Association for General Practice, 2010). The study was approved by the Ethical Boards of the Hospital District of Helsinki and Uusimaa and Cities of Helsinki and Espoo, and all subjects signed an informed consent.

The overall design of the RCT is illustrated in Figure 1. Eligible dyads (n = 89) were randomized to a singing group (SG), a music listening group (MLG), and a usual care control group (CG), and were followed for 9 months. The goal of the music intervention groups was to encourage, motivate, and guide the caregivers to use either singing or music listening regularly with the PWD to enhance mood, increase reciprocal communication, and support the cognitive abilities of the PWD. The randomization was done a priori as block randomization (6 blocks of 15 dyads) with a random number generator by a staff member not involved in data collection. The cognitive abilities, mood, and QOL of the PWDs and the psychological well-being of their family members were assessed at three time points: before the intervention (baseline), immediately after the intervention (Follow-up 1, 3 months from baseline), and 6 months after the end of the intervention (Follow-up 2, 9 months from

Table 1. Baseline Demographic and Clinical Characteristics of the PWDs ($n = 84$)

	SG ($n = 27$)	MLG ($n = 29$)	CG ($n = 28$)	p
Demographical variables				
Age	78.5 (10.4)	79.4 (10.1)	78.4 (11.6)	.927 (F)
Gender (female/male)	16/11	26/3	18/10	.025 (χ^2)
Education level[a]	3.0 (1.7)	2.8 (2.0)	3.0 (1.7)	.857 (F)
Living situation (home/interval or long-term care)	14/13	14/15	11/17	.627 (χ^2)
Dyad partner (spouse/child/sibling or other relative/nurse)	12/5/3/7	8/5/5/11	9/9/3/7	.633 (χ^2)
Clinical variables				
Dementia etiology (AD/VD/MD/other)	12/6/4/5	14/7/4/4	14/6/3/5	.997 (χ^2)
Years from symptom onset[b]	4.4 (2.4)	4.5 (2.8)	5.4 (2.9)	.384 (F)
Dementia medication[c] (yes/no)	19/8	16/13	19/9	.440 (χ^2)
Antipsychotic medication[d] (yes/no)	4/23	8/21	7/21	.487 (χ^2)
Antidepressant medication[e] (yes/no)	14/13	15/14	19/9	.374 (χ^2)
Sedative or sleeping medication[f] (yes/no)	15/12	16/13	17/11	.896 (χ^2)
CDR total score	1.0 (0.6)	1.6 (0.5)	1.1 (0.5)	.001 (F)
Current leisure activities				
Physical exercise[g]	2.4 (1.1)	2.2 (1.3)	2.0 (1.1)	.410 (F)
Social activities[g]	1.9 (0.8)	1.7 (0.8)	1.9 (0.7)	.756 (F)
Singing[h]	2.5 (1.8)	2.0 (1.8)	1.9 (1.2)	.386 (F)
Music listening[h]	4.5 (0.9)	4.5 (0.9)	4.2 (1.2)	.799 (H)
Playing a musical instrument[h]	0.1 (0.8)	0.1 (0.4)	0.3 (1.0)	.604 (H)
Dancing or other musical exercise[h]	0.8 (1.0)	0.9 (1.3)	1.1 (1.3)	.701 (H)
Musical background (starting from childhood)				
Singing (yes/no)	12/15	14/15	17/11	.448 (χ^2)
Playing a musical instrument (yes/no)	14/13	13/16	13/15	.861 (χ^2)
Dancing or other musical exercise (yes/no)	8/19	6/23	9/19	.594 (χ^2)

Notes. Data are *M* (*SD*) unless otherwise stated. SG = singing group; MLG = music listening group; CG = control group; F = one-way analysis of variance; χ^2 =chi-square test; AD = Alzheimer's disease; VD = vascular dementia; MD = mixed dementia; CDR = Clinical Dementia Rating; H = Kruskal–Wallis test.

[a]7-point Likert scale with a range 1 (*primary education*) to 7 (*doctoral level*).

[b]Verified from a next of kin.

[c]Acetylcholinesterase inhibitors or *N*-methyl-D-aspartate receptor blockers.

[d]Quetiapine, risperidon, haloperidol, or olanzapine.

[e]Citalopram, mirtazapine, or duloxetine.

[f]Benzodiazepines, zopiclone, or zolpidem.

[g]5-point Likert scale with a range 0 (*never*) to 4 (*daily*).

[h]6-point Likert scale with a range 0 (*never*) to 5 (*daily*)

baseline). All assessments were carried out blinded to the group allocation of the participants.

Outcome Measures

A comprehensive neuropsychological testing battery (see Table 2) was used to evaluate the following cognitive domains: general cognition, orientation, short-term and working memory, verbal learning, delayed memory, verbal skills, visuospatial skills, and attention and executive function. In order to reduce the number of variables and increase the internal reliability of the domains, summary scores of the tests (raw scores) measuring each cognitive domain were used in the statistical analyses (Särkämö et al., 2008). The testing (duration 1.5 hr) was carried out in a quiet room at the own care unit or home of the PWD by a licensed psychologist (T. Särkämö). Parallel versions of the memory tests were used in different testing occasions in a counter-balanced way. In addition to the standard neuropsychological tests, we included a modified version of the autobiographical fluency task (Dritschel, Williams, Baddeley, & Nimmo-Smith, 1992) as a measure of personal episodic memory. In the task, the PWD was given 90 s to

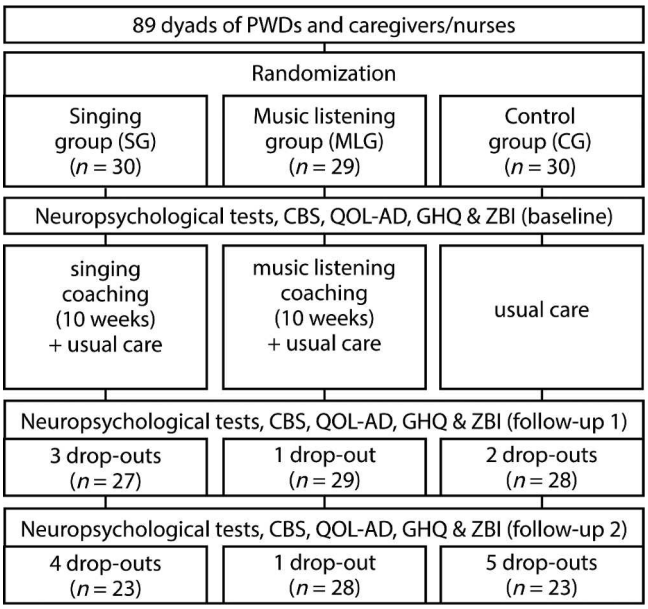

Figure 1. Study design. CBS = Cornell-Brown Scale for Quality of Life in Dementia, GHQ = General Health Questionnaire, PWD = person with dementia, QOL-AD = Quality of Life in Alzheimer's Disease, ZBI = Zarit Burden Interview.

list as many names of familiar persons (e.g., relatives or friends; first names sufficed) as possible. After the completion of the task, the researcher reviewed the names with the PWD and asked who the persons were and from which age had the PWD known them (childhood [age < 15]/youth [age 15–24]/adulthood [age 25–60]/old age [age > 60]).

Mood and QOL of the PWDs were evaluated with the Cornell-Brown Scale for Quality of Life (CBS; Ready, Ott, Grace, & Fernandez, 2002) and the Quality of Life in Alzheimer's Disease (QOL-AD; Logsdon, Gibbons, McCurry, & Teri, 2002) scales. The CBS is a modification of the Cornell Scale for Depression in Dementia, and it includes 19 bipolar items (e.g., anxiety–comfort, sadness–happiness, lack of reactivity to pleasant events–enjoyment of life's pleasant events) measuring affectivity, ideational and behavioral disturbances, and physical signs and cyclic variations associated with depression. For the QOL-AD, a 15-item version (Edelman, Fulton, Kuhn, & Chang, 2005) was used, which included items concerning current health, psychological status, behavioral competence, interpersonal environment, and self-perception. For both CBS and QOL-AD, total (summary) scores were used in the statistical analyses. Both CBS and QOL-AD were administered in an interview format in conjunction with the neuropsychological testing. The caregivers also filled informant-report versions of CBS and QOL-AD as questionnaires. For the 30 PWDs who took part in the intervention together with their nurses, these data were obtained from family members in 13 cases (mostly children whose work commitments prevented them from taking part in the intervention) and from the nurses in 12 cases (in five cases, the data were missing). For the QOL-AD, we performed the group analyses from the self-report scores, the caregiver-report scores, and compound scores (average of self-report and caregiver-report scores). With the CBS, following the guidelines and protocol of the administration manual (http://med.brown.edu/neurology/articles/cbsmanual.pdf), a single score was formed by the experimenter for each item based on the interview with the PWD, the questionnaire filled by the caregiver, and the clinical judgment.

The psychological well-being of the family members of the PWDs (n = 59) was evaluated with short, 12-item versions of the General Health Questionnaire (GHQ) (Goldberg & Williams, 1988) and the Zarit Burden Interview (ZBI) (Bédard et al., 2001). The GHQ contains questions related to anxiety and depression, social dysfunction, and loss of confidence, and the ZBI contains questions about the experienced strain and burden as a caregiver. Total (summary) scores were used in the statistical analyses. In addition, a short semistructured telephone interview was conducted at Follow-up 2 in which the caregivers were asked the following questions: "Has the singing/music listening been beneficial for the PWD?" (10-point Likert scale: 0 = *not beneficial*, 10 = *extremely beneficial*), "Has the singing/music listening been beneficial (a) for

Table 2. Neuropsychological Testing Battery

Test	Task of the subject	Reference
General cognition		
MMSE total score	Perform a set of short cognitive tasks	Folstein, Folstein, and McHugh (1975)
Orientation		
MMSE orientation items	Answer ten questions about current time and place	Folstein, Folstein, and McHugh (1975)
Short-term and working memory		
MMSE memory items	Recall three words after a short interfering task	Folstein, Folstein, and McHugh (1975)
WMS-III backward digit span	Recall a sequence of digits in reverse order	Wechsler (1997b)
WMS-III logical memory I	Recall a short story	Wechsler (1997b)
Verbal learning		
CERAD word-list learning	Recall a list of ten words (three trials)	Morris et al. (1989)
Delayed memory		
WMS-III logical memory II	Recall the short story after a 20-min delay	Wechsler (1997b)
CERAD word-list delayed recall	Recall the word list after a 20-min delay	Morris et al. (1989)
Verbal skills		
MMSE verbal items	Name two objects, repeat a sentence, complete a 3-step command, read a sentence, write a sentence	Folstein, Folstein, and McHugh (1975)
WAIS-III similarities	Find a conceptual similarity between two words	Wechsler (1997a)
CERAD verbal fluency	List as many animals as possible during 60 seconds	Morris et al. (1989)
BNT (shortened version)	Name objects from 30 line drawings	Kaplan, Goodglass, and Weintraub (1983)
WAB sequential commands	Follow a set of verbal instructions	Kertesz (1982)
Visuospatial skills		
MMSE copying task	Copy two overlapping pentagons	Folstein, Folstein, and McHugh (1975)
WAIS-III block design	Put colored blocks together to make designs	Wechsler (1997a)
TMT part A	Draw a line to connect numbers 1–25 in ascending order	Reitan (1958)
Attention and executive function		
MMSE calculation items	Mentally count backwards from 100 by 7	Folstein, Folstein, and McHugh (1975)
FAB total score	Perform six short cognitive and motor tasks	Dubois, Slachevsky, Litvan, and Pillon (2000)

Note. MMSE = Mini-Mental State Examination; WMS-III = Wechsler Memory Scale III; CERAD = Consortium to Establish a Registry for Alzheimer's Disease battery; WAIS-III = Wechsler Adult Intelligence Scale III; BNT = Boston Naming Test; WAB = Western Aphasia Battery; TMT = Trail Making Test; FAB = Frontal Assessment Battery.

you personally and (b) for your interaction with the PWD?" (10-point Likert scale: 0 = *not beneficial*, 10 = *extremely beneficial*), and "How often have you used singing/music listening together with the PWD during the past 6 months?" (5-point Likert scale: 0 = *never*, 1 = *seldom*, 2 = *1 × week*, 3 = *2–3 × week*, 4 = *5 × week*; time in minutes per session).

Music Intervention

The music intervention was carried out as a 10-week group-based music coaching program, which included either singing sessions (SG) or music listening sessions (MLG). The singing and music listening sessions were held weekly (1.5 hr/session) at each center for a group of 10 participants (5 PWDs, 5 caregivers), and they were led by a trained music teacher or music therapist, respectively. Specifically, the SG sessions consisted primarily of singing songs in a group accompanied by the music teacher on the piano, guitar, or kantele (Finnish zither), as well as occasionally performing physically activating vocal exercises and rhythmical movements during the singing (e.g., clapping, playing maracas). Pedagogically, the singing sessions followed the Finnish KeyToSong method (www.keytosong.fi),

which is designed for persons with no singing background and which puts a special emphasis on a supportive, engaging, and fun singing atmosphere (Numminen, 2005). In MLG, the sessions consisted primarily of listening to songs from CD and discussing about the emotions, thoughts, and memories (e.g., personal events, people, and places) that they evoked. Also visual cues (e.g., album covers) were used to stimulate reminiscence and discussion. The focus was on building a soothing and relaxing atmosphere that would encourage emotional expression, free reminiscence, and open reciprocal communication (Ridder, 2005).

In both SG and MLG, the music (6–10 songs/session) consisted primarily of traditional folk songs and popular songs from the 1920s to 1960s. The songs were selected based on the individual musical preferences of the PWDs and were, thus, highly familiar and autobiographically and emotionally important to them. Each session had a specific theme (see Table 3) that focused, for example, on music from certain era of life (e.g., childhood or adolescence) or on how to utilize music in everyday life for different purposes (e.g., for relaxation, reminiscence, or vitalization). After sessions 4–9, the participants were also given weekly "musical homework assignments" (see Table 3), which involved either singing (SG) or listening to music (MLG), with the aim of rooting the music activity to the everyday home setting. At the final session, the participants were given song books (SG) or compiled CDs (MLG) of their favorite songs and were encouraged to continue the musical activities at home on a regular basis.

Usual Care Control Group

The participants in the CG were not given any additional activities and were instructed to continue with their normal everyday activities and hobbies throughout the follow-up. Typically, this

Table 3. Themes of the Music Coaching Sessions

Session	Main theme	Subthemes and activities
1	Becoming acquainted (caregivers only)	What is your musical background? What is your favorite music? What do you know about the favorite music or songs of the PWD?
2	Forming a group	Who are you? How do you feel about music? (playing music examples, singing/listening[a] and discussing)
3	Musical memories	Is this music familiar to you? Who was the artist? When did you sing/hear these songs? How does the music sound to you? (singing/listening[a] and discussing, musical relaxation at the end)
4	Musical memories	Singing/listening[a] and discussing about the memories and feelings that the music evokes. Homework: choose a song with the PWD and bring it here the next week/choose a record with the PWD and bring it here next week.
5	Childhood memories	Remembering the childhood through children's songs. Singing/listening[a], discussing and sharing the experience with the group. Homework: sing together with the PWD at least once during the week/listen to familiar songs together with the PWD and discuss about the memories they evoke at least once during the week.
6	Adolescence memories	Recalling the adolescence era through music. Singing/listening[a], discussing and sharing the experience with the group. Homework: prepare a song with the PWD and conduct it to others next week/listen to familiar songs together with the PWD and discuss about their importance and meaning during the life span.
7	Relaxation with music	How to relax with music? Soothing instrumental music and relaxation exercise with gentle massage. Sharing the experience with the group. Homework: sing together with the PWD and choose one of your favorite songs and bring it with you/listen to songs together while giving the PWD a gentle back and shoulder massage.
8	Activating music	What music activates you? Singing/listening[a] rhythmic music and sharing the experience in the group. Homework: sing together and help the PWD to move to the music/listen to rhythmic music with the PWD (e.g., marches) and observe his/her behavior.
9	My music story	Singing/listening[a], choosing favorite songs and collecting the song lyrics/CDs so that they are available for everyone who visits or works with the PWD. Homework: sing together and write a list of the songs you can sing with your PWD/listen to music together with other friends or inhabitants.
10	Remember that song!	Singing/listening[a], collecting the experiences of the group, thanking everyone for attending, and encouraging the dyads to sing/listen to music together regularly

[a]Singing in the singing group, listening in the music listening group.

consisted of common group-based physical or social activities (e.g., physical exercise, handicraft, reading, and discussion) held at each center a couple of times per week. After the 9-month follow-up period, the CG participants were given the opportunity to take part in a musical activity group similar to SG and MLG.

Data Analysis

Group differences in the baseline characteristics of the participants were analyzed with one-way analyses of variance (ANOVA), Kruskal–Wallis tests, and chi-square tests. Longitudinal changes in the outcome measures were analyzed using mixed-model ANOVAs with time as a within-subjects factor and group as a between-subjects factor. Separate mixed-model ANOVAs were performed to determine the short-term (baseline vs. Follow-up 1), long-term (baseline vs. Follow-up 2), general (SG and MLG combined vs. CG), and specific (SG vs. MLG vs. CG) effects of the intervention. If there was a discernible group difference ($p \leq .1$) on the outcome variable at baseline, the results were also analyzed using an analysis of covariance (ANCOVA) with the follow-up score (3 months/9 months) as a dependent variable, group as a factor, and the baseline score as a covariate. For the mixed-model ANOVA/ANCOVA analyses, all post hoc analyses were performed on the change scores (Follow-up 1 minus baseline, Follow-up 2 minus baseline) using Tukey's Honestly Significant Difference test (HSD). All statistical analyses were performed using PASW Statistics 18.

Results

Group Characteristics

As shown in Figure 1, 84 (94.4%) PWDs completed the study up to Follow-up 1 and 74 (83.1%) up to Follow-up 2. The characteristics of the PWDs ($n = 84$) who completed the study up to Follow-up 1 are presented in Table 1. There were no statistically significant differences between the PWDs who completed the study ($n = 74$) and who dropped out ($n = 15$) on any potentially confounding variables, including gender, education level, general cognition at baseline, or group membership. There were also no significant differences between the SG, MLG, and CG on most demographic and clinical characteristics (Table 1). Only the proportion of women and the CDR scores were found to differ between the groups, with more women and higher CDR scores (indicating more advanced dementia) in the MLG than in the SG or CG. Similarly, an analysis of outcome measures at baseline (Table 4) indicated that there were group differences in general cognition, orientation, delayed memory, and CBS with lower scores again in the MLG than in the other groups. Because the participants were randomized,

Table 4. Outcome Measures at Baseline

	SG ($n = 27$)	MLG ($n = 29$)	CG ($n = 28$)	p
Cognitive domains (PWD)				
General cognition (maximum 30)	19.0 (5.7)	15.4 (5.4)	20.3 (5.1)	.004 (F)
Orientation (maximum 10)	6.7 (2.3)	4.6 (2.1)	6.4 (2.4)	.001 (F)
Short-term and working memory (max. 42)	7.6 (4.5)	6.3 (4.4)	8.7 (5.6)	.172 (F)
Verbal learning (maximum 30)	10.3 (15.6)	8.3 (5.1)	10.3 (5.6)	.304 (F)
Delayed memory (maximum 35)	3.9 (4.4)	1.5 (3.1)	3.7 (5.5)	.050 (H)
Verbal skills (maximum 173)	111.3 (34.4)	104.9 (27.2)	119.1 (21.5)	.179 (F)
Visuospatial skills (maximum 93)	30.5 (15.3)	29.7 (14.4)	30.8 (14.7)	.970 (F)
Attention and executive function (maximum 23)	12.4 (4.8)	11.3 (4.6)	13.5 (4.8)	.246 (F)
Mood and quality of life (PWD)				
CBS total score (range –38 to 38)	4.9 (8.6)	0.6 (11.1)	7.8 (9.7)	.026 (F)
Self-report QOL-AD total score (maximum 60)	36.2 (6.3)	34.9 (5.0)	37.6 (5.3)	.185 (F)
Caregiver-report QOL-AD total score (maximum 60)	33.5 (6.2)	31.2 (5.6)	33.1 (5.6)	.324 (F)
Psychological well-being (family member)				
GHQ total score (maximum 36)	14.6 (6.7)	10.3 (5.5)	11.3 (4.9)	.071 (F)
ZBI total score (maximum 48)	13.8 (7.4)	15.2 (7.6)	14.5 (8.0)	.854 (F)

Notes. Data are *M* (*SD*). SG = singing group; MLG = music listening group; CG = control group; PWD = person with dementia; F = one-way analysis of variance; H = Kruskal–Wallis test; CBS = Cornell-Brown Scale for Quality of Life in Dementia; QOL-AD = Quality of Life in Alzheimer's Disease; GHQ = General Health Questionnaire; ZBI = Zarit Burden Interview.

these effects are most likely due to chance; however, they were controlled for statistically in the longitudinal group comparisons (see Data Analysis).

During the intervention period, the participant dyads were able to take part in most of the nine group sessions (M = 8.0, SD = 1.3) and performed a majority of the six musical homework assignments (M = 3.4, SD = 2.0). In the phone interview conducted at Follow-up 2, over two-thirds (68%) of the caregivers reported having used the trained musical activities (singing or music listening) together with the PWDs after the intervention at least once per week (1–5 × week) for an average duration of 46.7 min (SD = 32.7 min). As shown in Table 5, the average frequency of the postintervention music sessions was higher in the MLG than in the SG (M = 2.5, SD = 1.3 vs. M = 1.6, SD = 1.2; $t(48) = -2.7$, p = .010). The music sessions were also somewhat longer in duration in the MLG than in the SG. Overall, these results suggest that music listening was experienced as a somewhat easier way to interact with the PWD in the home setting. In both music intervention groups, the caregivers rated the musical activities as being highly beneficial for themselves, as well as for their interaction with the PWD. Taken together, these results suggest that the implementation of the coaching protocol was successful and that caregivers had later continued to arrange musical activities with the PWD on a regularly basis and also had found them beneficial.

Cognitive Performance of the PWDs

Figure 2 illustrates the changes in the eight cognitive domains over the 9-month period in all three PWD groups. Regarding the short-term general effects, significant Time × Group interactions indicated that the music interventions improved performance on tasks of general cognition, $F(1, 77) = 4.3$, p = .041, and attention and executive function, $F(1, 77) = 4.4$, p = .039, compared with the CG. In the ANCOVA controlling for baseline group differences in the variables (see Data Analysis), these effects remained marginally significant for both general cognition, $F(1, 76) = 3.7$, p = .058, and attention and executive function, $F(1, 76) = 3.1$, p = .083. In addition, analyses of the short-term specific effects showed a highly significant Time × Group interaction for short-term and working memory performance, $F(2, 76) = 5.4$, p = .006, which according to post hoc tests (Tukey HSD) improved more in the SG than in the CG (p = .006) and MLG (p = .074). For the whole 9-month follow-up, a highly significant long-term general effect was observed for orientation level (mixed-model ANOVA Time × Group interaction, $F(1, 67) = 8.5$, p = .005; ANCOVA group effect $F(1, 66) = 7.1$, p = .010), which declined less in the music intervention groups than in the CG. There were no other significant effects. In summary, regular musical activity had a temporary minor positive effect on overall cognitive level and attention and executive function, as well as a long-term effect on orientation, whereas singing had a temporary positive effect specifically on short-term and working memory.

When considering the personal episodic memory as measured by the autobiographical verbal fluency task (Figure 3), at baseline a one-way ANOVA showed no significant group differences for the

Table 5. Experiences of the Caregivers 6 months After the Coaching

	Singing group	Music listening group
Frequency of music sessions[a]		
5 × week	0 (0 %)	6 (24 %)
2–3 × week	6 (24 %)	8 (32 %)
1 × week	9 (36 %)	5 (20 %)
Rarely	3 (12 %)	4 (16 %)
Never	7 (28 %)	2 (8 %)
Duration of a single music session (min)[b]	37.1 (28.4)	53.5 (34.4)
Experienced utility of the musical activity[c]		
Beneficial for self	8.5 (1.0)	8.2 (1.3)
Beneficial for interaction with the PWD	7.4 (2.4)	8.3 (1.1)

Note. PWD = person with dementia.

[a]Frequency of providing music sessions for the PWD after the coaching (6-month period). Data are numbers and percentages of responses.

[b]Data are M (SD).

[c]Data are M (SD), 10-point Likert scale: 1 (*not at all beneficial*) to 10 (*extremely beneficial*).

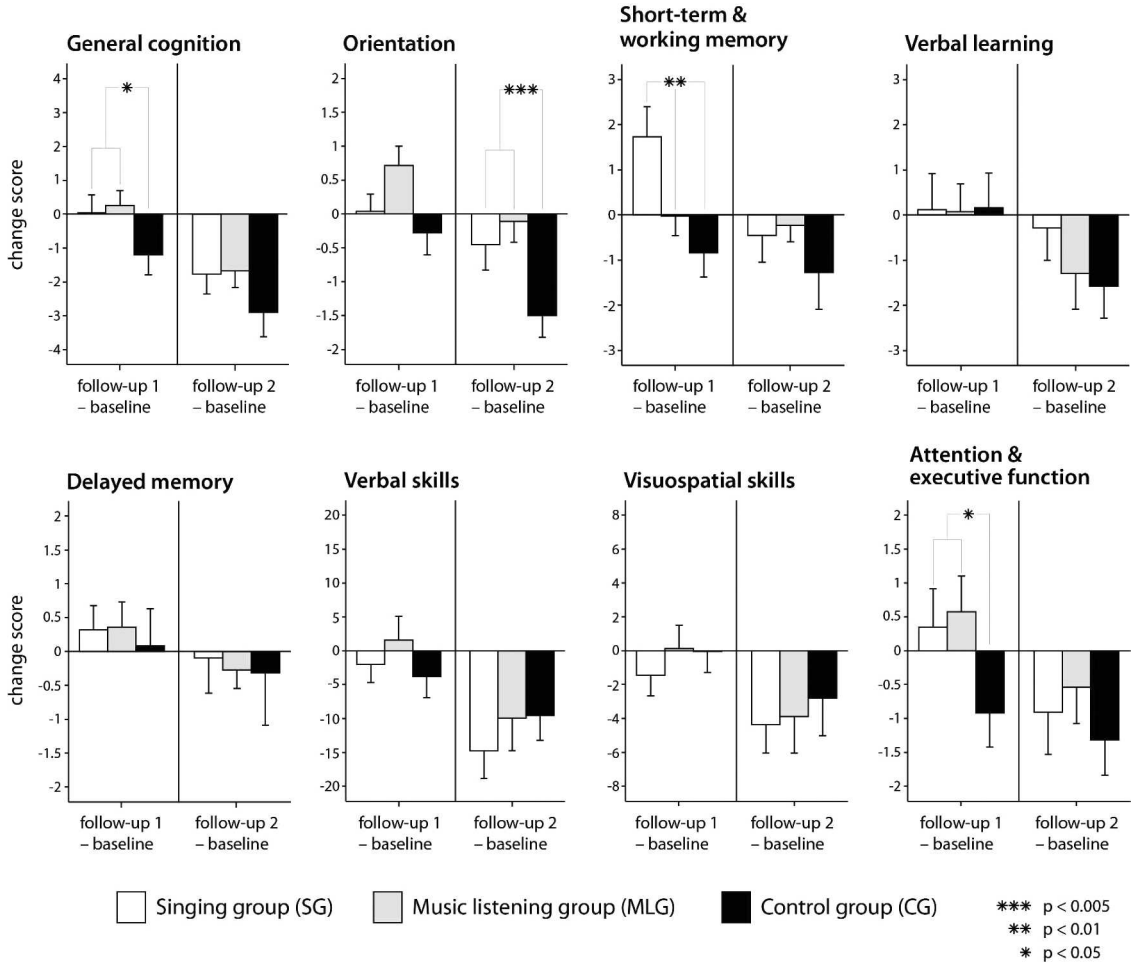

Figure 2. Changes in the eight cognitive domains (*mean* ± standard error of the mean) immediately after the intervention (Follow-up 1 minus baseline) and 6 months after the intervention (Follow-up 2 minus baseline). $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .005$ by mixed-model analysis of variance (Time × Group interaction).

total number of persons recalled or for the number of persons recalled from the childhood era. In a mixed-model ANOVA, no effects were observed for the total number of recalled persons over time. However, a significant long-term general effect was observed for the number of recalled persons from the childhood era (mixed-model ANOVA Time × Group interaction $F(1, 62) = 4.6, p = .036$), which increased more or remained better in the music intervention groups than in the CG. As illustrated in Figure 3, singing seemed to be especially effective in evoking these remote personal memories.

Mood and QOL of the PWD

Figure 4 shows the changes in mood (CBS) and QOL (QOL-AD) of the PWDs over the 9-month period in all three groups. In the mixed-model ANOVA/ANCOVA, a highly significant short-term general effect was observed for the CBS scores, which increased (indicating reduced depression symptoms or improved mood) in the music intervention groups compared with the CG (mixed-model ANOVA Time × Group interaction $F(1, 81) = 12.9, p = .001$; ANCOVA group effect $F(1, 80) = 7.9, p = .006$). There was a trend for a similar effect also at the longitudinal Follow-up 2, but this did not reach statistical significance, Time × Group $F(1, 71) = 2.5, p = .116$. For the QOL-AD, there was a long-term specific effect in the self-report total scores (Time × Group: baseline/Follow-up 1 $F(2, 74) = 3.2, p = .048$; baseline/Follow-up 2 $F(2, 64) = 4.1, p = .021$). Post hoc tests indicated that the self-report QOL-AD scores increased (indicating improved QOL) more in the MLG than in the CG ($p = .069$) from baseline to Follow-up 1 and more in the MLG than in both the SG ($p = .033$) and the CG ($p = .066$) from baseline to Follow-up 2. The same effect was marginally significant also in the caregiver-report QOL-AD scores (Time × Group: baseline/Follow-up 1 $F(2, 71) = 2.4, p = .101$; baseline/Follow-up 2 $F(2, 63) = 2.5, p = .092$)

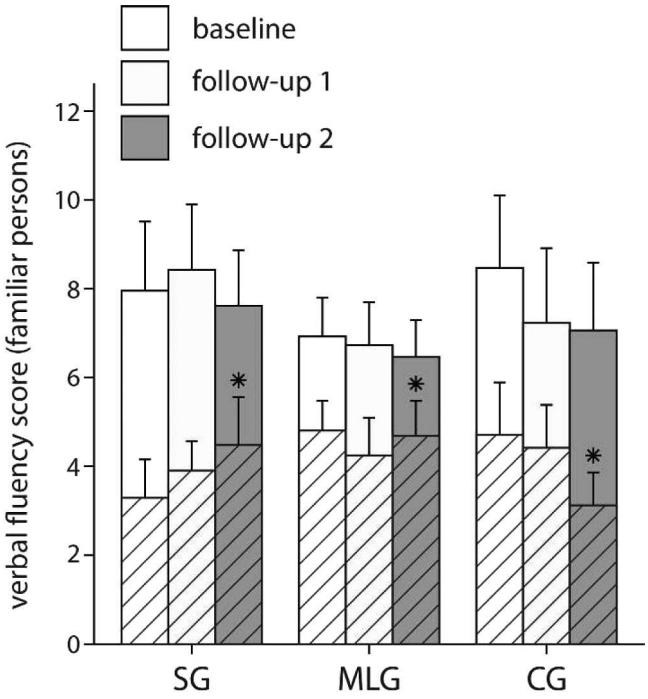

Figure 3. Performance in a verbal fluency task for familiar persons (mean ± standard error of the mean) before (baseline) and immediately after the intervention (Follow-up 1) and 6 months later (Follow-up 2). The bars with cross-lines indicate the recalled persons from the childhood era. *$p < .05$ by mixed-model analysis of variance (Time × Group interaction). CG = control group, MLG = music listening group, SG = singing group.

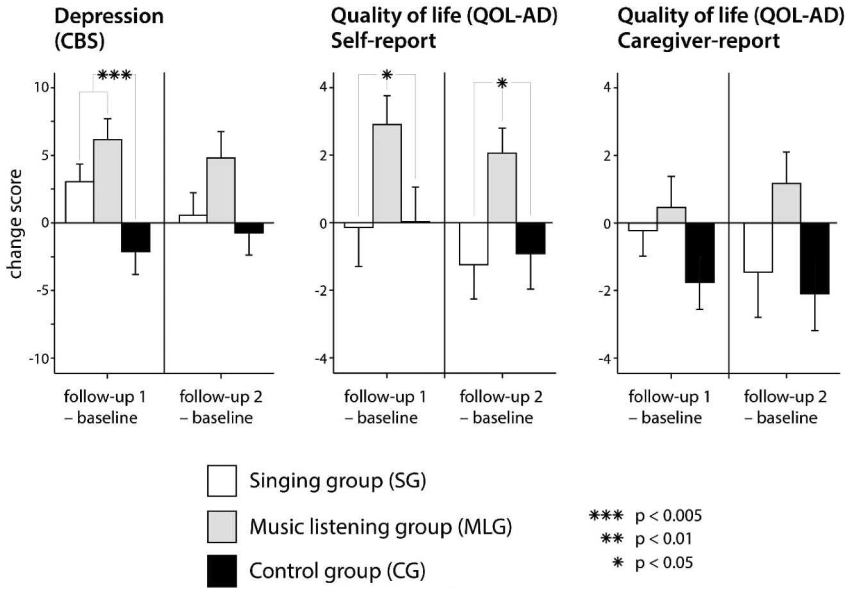

Figure 4. Changes (mean ± standard error of the mean) in the mood (Cornell-Brown Scale for Quality of Life in Dementia, CBS) and the quality of life (Quality of Life in Alzheimer's Disease, QOL-AD) of the PWD immediately after the intervention (Follow-up 1 minus baseline) and 6 months after the intervention (Follow-up 2 minus baseline). *$p < .05$, **$p < .01$, ***$p < .005$ by mixed-model analysis of variance (Time × Group interaction).

with the MLG again improving more than the CG from baseline to Follow-up 1 ($p = .095$) and to Follow-up 2 ($p = .096$). Thus, the self-report and caregiver-report scores yielded a very similar pattern of results. Because they were also significantly correlated at Follow-up 2 ($r = .33$, $p = .004$), we performed an additional mixed-model ANOVA (including both self-report and caregiver-report scores) that yielded a significant multivariate Time × Group interaction, Wilk's lambda 0.8,

$F(4, 110) = 3.1$, $p = .018$). Post hoc tests of the compound QOL-AD scores (averages of self-report and caregiver-report scores) indicated that there was significantly more increase in the MLG than in the CG ($p = .030$) from baseline to Follow-up 1 and also more increase in the MLG than in both the SG ($p = .007$) and the CG ($p = .020$) from baseline to Follow-up 2. In summary, regular musical activities, in general, were effective in temporarily improving mood, whereas only music listening improved QOL in the long run.

Emotional Well-Being of the Family Members

Figure 5 shows the change in the psychological stress (GHQ) and burden (ZBI) of the family members over the 9-month period in all three groups. A significant long-term specific effect was observed for the ZBI scores, Time × Group $F(2, 44) = 4.0$, $p = .026$, which decreased (indicating reduced burden) more in the SG than in both MLG ($p = .029$) and CG ($p = .069$) from baseline to Follow-up 2. The same effect was observed also for the GHQ, but it failed to reach statistical significance (Time × Group $F(2, 44) = 2.5$, $p = .095$; ANCOVA group effect $F(2, 43) = 1.8$, $p = .174$). Thus, it appears that singing, in particular, was beneficial for the emotional well-being of the family members.

In order to determine if the extent to which the caregivers had used the trained musical activities after the intervention was associated with its long-term effectiveness, we performed correlation analyses (Spearman) between the frequency of music sessions provided by the caregivers in the SG and the MLG at home during the 6-month postintervention period and the outcome measures that showed a positive effect after the intervention. At Follow-up 2, the frequency of postintervention music sessions correlated significantly with higher CBS scores within both music intervention groups ($r = .38$, $p = .005$), with higher self-report QOL-AD scores within the MLG ($r = 0.42$, $p = .022$), as well as with better short-term and working performance within the SG ($r = .50$, $p = .013$). There were no other significant correlations. Thus, continuing the musical activities regularly at home seems to be linked to better mood, QOL, and memory of the PWDs.

Discussion

The novel finding of the present RCT was that everyday musical leisure activities, such as regular singing and listening to familiar songs, provided by the caregivers of PWDs can be cognitively, emotionally, and socially beneficial. Compared with usual care, both singing and music listening were found to maintain or enhance general cognition, orientation, attention and executive function, and remote personal episodic memory of the PWDs, as well as to improve their mood. In addition, singing had a specific enhancing effect on the short-term

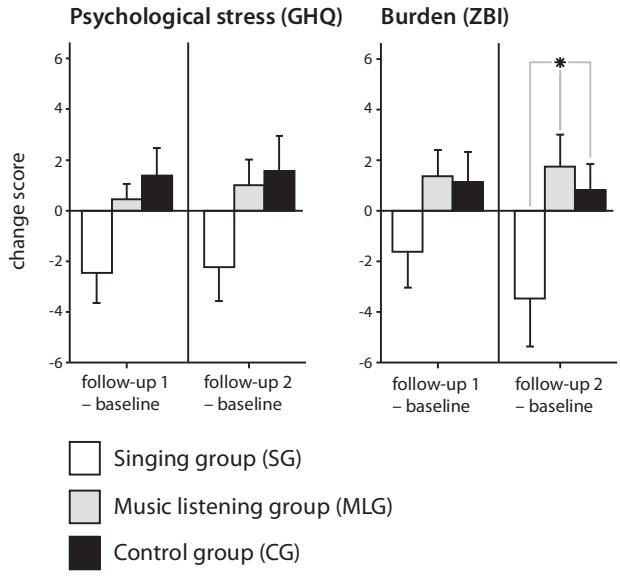

Figure 5. Changes (mean ± standard error of the mean) in the psychological stress (Global Health Questionnaire, GHQ) and burden (Zarit Burden Interview, ZBI) of the family members of the PWD immediately after the intervention (Follow-up 1 minus baseline) and 6 months after the intervention (Follow-up 2 minus baseline). *$p < .05$ by mixed-model analysis of variance (Time × Group interaction).

and working memory of the PWDs and on the emotional well-being of their family members, whereas music listening was found to improve the QOL of the PWDs.

Regarding the emotional and cognitive effects of musical activities, the results are in line with previous studies of PWDs, which have shown that emotional reactions to music are usually preserved in advanced dementia (Cuddy & Duffin, 2005; Johnson et al., 2011); that music therapy and caregiver-implemented music interventions can reduce agitation, depression, and anxiety (Clair, 2002; Garland et al., 2007; Götell et al., 2003; Guétin et al., 2009; Raglio et al., 2008); and that music-based interventions can temporarily improve verbal and episodic memory and overall cognitive functioning (Bruer et al., 2007; Foster & Valentine, 2001; Hokkanen et al., 2008; Irish et al., 2006; Thompson et al., 2005; Van de Winckel et al., 2004). Importantly, the present study extends these findings by showing that also regular everyday musical leisure activities, such as singing or music listening, can have long-term emotional and cognitive benefits in early dementia, as has previously been found with healthy elderly persons (Bugos et al., 2007; Cohen et al., 2006; Hanna-Pladdy & MacKay, 2011; Kattenstroth et al., 2010; Mammarella et al., 2007; Parbery-Clark et al., 2011; Verghese et al., 2003; Zendel & Alain, 2012) as well as with elderly stroke patients (Särkämö et al., 2008). The positive effect of singing and music listening on depressed mood was clearly seen on the CBS immediately after the intervention. A similar trend was apparent also 6 months after the intervention, although it failed to reach statistical significance. However, within the intervention groups, there was a clear correlation between the frequency of music sessions provided by the caregivers during the 6-month postintervention period and higher CBS scores at Follow-up 2, providing tentative evidence that continuing the musical activities at home may be beneficial for the mood of the PWD in the long run. Cognitively, both singing and music listening had a positive effect on general cognition (MMSE total score), attention and executive function, orientation, and remote personal episodic memory. The effects on general cognition and on attention and executive function were seen immediately after intervention period, whereas the effects on orientation and personal episodic memory were seen 6 months after the intervention. Statistically, the effects on general cognition and attention and executive function were only marginally significant after controlling for baseline differences (ANCOVA analyses), suggesting that they should be interpreted with some caution. Overall, this pattern of results suggests that intensive engagement with familiar songs in a group can be cognitively stimulating and enhance vigilance and concentration (possibly owing at least partly to the social interaction provided by the group), whereas continuing the musical activity regularly at home can help to maintain better orientation to the environment and also to evoke associative memories from one's past.

We also observed therapeutic effects that were specific to either singing or music listening. These effects are particularly important and informative as they provide information about the potential rehabilitative facets of music that are specific to more active production (singing) and more passive reception (listening) of music while controlling for the general effect of receiving therapeutic attention. Compared with both usual care (CG) and music listening (MLG), singing (SG) was found to improve performance on short-term and working memory tasks immediately after the intervention. Correlation analyses also indicated that those PWDs in the SG with whom the caregivers continued to provide regular music sessions after the intervention had better short-term and working memory performance at Follow-up 2, tentatively suggesting that continuing the singing activity at home could potentially be beneficial for maintaining the level of memory in the PWDs. Supporting evidence for the effect of singing on memory comes from behavioral and neuroimaging studies showing that singing recruits not only auditory and motor brain regions but also brain regions associated with working memory, such as the dorsolateral and inferior prefrontal cortex, anterior cingulate cortex, and the inferior parietal lobe (Brown et al., 2006; Hickok et al., 2003; Kleber et al., 2010; Perry et al., 1999), and that exposure to music and musical training are associated with better working memory performance (Mammarella et al., 2007; Parbery-Clark et al., 2011) and better structural integrity of prefrontal cortical areas (Sluming et al., 2002) in old age. Singing was also found to reduce the psychological burden experienced by the family members of the PWDs 6 months after the intervention. This finding is in concordance with the reported positive effects of leisure activities on mood and QOL of family caregivers (Bruvik, Ulstein, Ranhoff, & Engedal, 2012; Romero-Moreno, Márquez-González, Mausbach,

& Losada, 2012), as well as the positive effects of a singing hobby on physical health and mental health in older adults (Cohen et al., 2006; Kreutz et al., 2004; Skingley & Bungay, 2010). This finding suggests that singing could perhaps be more widely used to promote the well-being of family members, many of whom are under severe mental stress and burden in their role as caregivers for the PWD. Finally, music listening was found to have a long-term positive effect on the QOL of the PWDs. Although some PWD music intervention studies (Cooke, Moyle, Shum, Harrison, & Murfield, 2010) have included QOL measures, to our best knowledge this is the first study to report a long-term positive effect of musical activity on the QOL of PWDs. The reason why only music listening and not singing was found to be beneficial is still unclear, but it may be related to the fact that implementing the music listening was apparently easier and less demanding for the caregivers, and consequently, they provided it more often during the 6-month follow-up than singing.

An important question still pertains as to how regular musical activities could enhance the emotional and cognitive functioning of PWD. One potential mechanism could be the positive contribution of leisure activities on brain and cognitive reserve (BCR), the ability of the brain to utilize alternative networks and cognitive strategies to cope with advancing pathology. Converging evidence from epidemiological studies suggests that stimulating cognitive activities in late life have a protective effect against dementia (Verghese et al., 2003), can delay the onset of memory decline in dementia (Hall et al., 2009), and are associated with slower cognitive decline in the early stage of AD and with better functional ability in later stages (Treiber et al., 2011). Corroborating findings from studies of transgenic AD mice indicate that a cognitively stimulating enriched environment can protect against cognitive impairment, decreased beta-amyloid deposition, and increased hippocampal synaptic immunoreactivity (Cracchiolo et al., 2007). Thus, although it is still somewhat unclear what the long-term effects of stimulating leisure activities (or BCR in general) are after the onset of dementia, it is possible that they might contribute to relatively better preservation of emotional and cognitive functioning also as the illness progresses. Currently, this topic is more of a hypothesis and clearly needs more study. Another potential mechanism could be the emotional impact of music (Juslin & Sloboda, 2011) and the corresponding neural activity associated with it, including subcortical and medial regions such as the amygdala, the nucleus accumbens, the ventral tegmental area, the cingulate, and the orbitofrontal cortex (Koelsch, 2010). In line with the concept of retrogenesis, many of these phylogenetically old regions mature early in life and also tend to degenerate last in AD (Ewers et al., 2011). Especially the preservation of the medial prefrontal cortex, a crucial neural hub for associating music, emotions, and memories, has been implicated as one potential mechanism as to why especially familiar music is remembered and evokes emotions in persons with severe and advanced AD (Janata, 2009). More generally, music engages an extremely widespread network of temporal, frontal, parietal, cerebellar, and limbic/paralimbic brain areas that are linked to many perceptual, cognitive, motor, and emotional processes in the brain (Alluri et al., 2012; Janata et al., 2002; Koelsch, 2010; Koelsch & Siebel, 2005; Zatorre et al., 2007). Behaviorally, the activity of this network and the autonomic nervous system and the neuroendocrine system to which it is closely linked most likely underlies the short-term positive effects of music on mood and arousal (mediated by the dopaminergic mesolimbic [reward] system and possibly the noradrenaline system], stress, and cognitive functioning (Särkämö & Soto, 2012). In the long run, repeated exposure to music or active musical training have also been shown to induce a number of neuroplastic changes in the brain, including increased neurotransmitter (e.g., dopamine, glutamate) and neurotrophin (e.g., brain-derived neurotrophic factor) levels, synaptic plasticity, and neurogenesis in animals (Angelucci et al., 2007; Rickard, Toukhsati, & Field, 2005), as well as increased gray and white matter volumes in many cortical and subcortical areas controlling auditory, motor, and cognitive skills in humans (Herholz & Zatorre, 2012; Hyde et al., 2009).

There are some methodological limitations to this study. First, due to practical constraints, we did not focus on any particular dementia type, which limits the specific conclusions that can be drawn about the effectiveness of the music intervention, for example, for persons with AD. However, the benefit of this approach is that the sample is representative of the wider PWD population, and the findings are therefore more generalizable. Second, we did not focus on the very early stage of dementia (stage of mild cognitive impairment or subjective memory impairment) during which regular musical activity might have been most

beneficial and potentially produce the best long-term outcomes. Third, owing to practical confines (e.g., funding, scheduling), the intervention period used in the study was relatively short. In order to establish musical activity, more firmly as a part of everyday care routine and to also see more robust long-term effects, the coaching period would perhaps need to be longer and more intensive, and possibly followed by periodic recapitulation sessions to encourage the caregivers to keep up the musical activities at home (especially the singing, which the caregivers engaged with less frequently than with music listening). Perhaps this would have helped to maintain the positive effects on mood and cognition, which were seen immediately after the coaching.

In conclusion, the results of the present study show for the first time that regular musical activities can have an important role in maintaining cognitive ability, enhancing mood and QOL, and promoting the well-being of family members in mild/moderate dementia. From a clinical standpoint, these findings are promising as they encourage the use of singing and music listening as beneficial leisure activities for both PWDs and their caregivers. In practice, the rehabilitative potential of music in the daily care of PWDs is often overlooked. If the caregiver has no special musical background, even the possibility of using music or singing may not occur to him/her. Similarly, many nurses who work with PWDs regard musical activities as a useful tool but feel that they lack the training to apply them regularly in their work (Sung, Lee, Chang, & Smith, 2011). Based on the present study, coaching the caregivers and nurses in using simple musical activities is an applicable and cost-efficient way for bringing emotionally and cognitively stimulating and enriching musical experiences to the lives of many elderly PWD.

Funding

This work was supported by the Miina Sillanpää Foundation (Helsinki, Finland), Finland's Slot Machine Association (grant no. C28), and the Academy of Finland (Finnish Centre of Excellence in Interdisciplinary Music Research, grant no. 141106).

Acknowledgments

We kindly thank the PWDs and their caregivers and nurses for participation in this study. We also thank Jennie Lilland, Milla Holma, Ilona Kiesilä, Hanna Clutterbuck, Tarja Lampinen, Raisa Saloheimo, Eija Sorvari, Miika Järvenpää, Marja Hietanen, Timo Erkinjuntti, and Laura Hokkanen for their assistance and expertise in planning and implementing the study. The generous collaboration of the Miina Sillanpää Foundation, the Helsinki Alzheimer Association, the Tapiola Service Centre, the Helsinki Senior Citizens Foundation, and the Kustaankartano Centre for the Elderly is also gratefully acknowledged.

References

Alluri, V., Toiviainen, P., Jääskeläinen, I. P., Glerean, E., Sams, M., & Brattico, E. (2012). Large-scale brain networks emerge from dynamic processing of musical timbre, key and rhythm. *Neuroimage*, *59*, 3677–3689. doi:10.1016/j.neuroimage.2011.11.019

Angelucci, F., Fiore, M., Ricci, E., Padua, L., Sabino, A., & Tonali, P. A. (2007). Investigating the neurobiology of music: Brain-derived neurotrophic factor modulation in the hippocampus of young adult mice. *Behavioural Pharmacology*, *18*, 491–496.

Bédard, M., Molloy, D. W., Squire, L., Dubois, S., Lever, J. A., & O'Donnell, M. (2001). The Zarit Burden Interview: A new short version and screening version. *The Gerontologist*, *41*, 652–657. doi:10.1093/geront/41.5.652

Brown, S., Martinez, M. J., & Parsons, L. M. (2006). Music and language side by side in the brain: A PET study of the generation of melodies and sentences. *The European Journal of Neuroscience*, *23*, 2791–2803. doi:10.1111/j.1460-9568.2006.04785.x

Bruer, R. A., Spitznagel, E., & Cloninger, C. R. (2007). The temporal limits of cognitive change from music therapy in elderly persons with dementia or dementia-like cognitive impairment: A randomized controlled trial. *Journal of Music Therapy*, *44*, 308–328.

Bruvik, F. K., Ulstein, I. D., Ranhoff, A. H., & Engedal, K. (2012). The quality of life of people with dementia and their family carers. *Dementia and Geriatric Cognitive Disorders*, *34*, 7–14. doi:10.1159/000341584

Bugos, J. A., Perlstein, W. M., McCrae, C. S., Brophy, T. S., & Bedenbaugh, P. H. (2007). Individualized piano instruction enhances executive functioning and working memory in older adults. *Aging & Mental Health*, *11*, 464–471. doi:10.1080/13607860601086504

Clair, A. A. (2002). The effects of music therapy on engagement in family caregiver and care receiver couples with dementia. *American Journal of Alzheimer's Disease and Other Dementias*, *17*, 286–290. doi:10.1177/153331750201700505

Cohen, G. D., Perlstein, S., Chapline, J., Kelly, J., Firth, K. M., & Simmens, S. (2006). The impact of professionally conducted cultural programs on the physical health, mental health, and social functioning of older adults. *The Gerontologist*, *46*, 726–734. doi:10.1093/geront/46.6.726

Cooke, M., Moyle, W., Shum, D., Harrison, S., & Murfield, J. (2010). A randomized controlled trial exploring the effect of music on quality of life and depression in older people with dementia. *Journal of Health Psychology*, *15*, 765–776. doi:10.1177/1359105310368188

Cracchiolo, J. R., Mori, T., Nazian, S. J., Tan, J., Potter, H., & Arendash, G. W. (2007). Enhanced cognitive activity–over and above social or physical activity–is required to protect Alzheimer's mice against cognitive impairment, reduce Abeta deposition, and increase synaptic immunoreactivity. *Neurobiology of Learning and Memory*, *88*, 277–294. doi:10.1016/j.nlm.2007.07.007

Cuddy, L. L., & Duffin, J. (2005). Music, memory, and Alzheimer's disease: Is music recognition spared in dementia, and how can it be assessed? *Medical Hypotheses*, *64*, 229–235. doi:10.1016/j.mehy.2004.09.005

Dalla Bella, S., Berkowska, M., & Sowiński, J. (2011). Disorders of pitch production in tone deafness. *Frontiers in Psychology*, *2*, 164. doi:10.3389/fpsyg.2011.00164

Dritschel, B. H., Williams, J. M., Baddeley, A. D., & Nimmo-Smith, I. (1992). Autobiographical fluency: A method for the study of personal memory. *Memory & Cognition*, *20*, 133–140.

Dubois, B., Slachevsky, A., Litvan, I., & Pillon, B. (2000). The FAB: A Frontal Assessment Battery at bedside. *Neurology*, *55*, 1621–1626. doi:10.1212/WNL.55.11.1621

Edelman, P., Fulton, B. R., Kuhn, D., & Chang, C. H. (2005). A comparison of three methods of measuring dementia-specific quality of life: Perspectives of residents, staff, and observers. *The Gerontologist*, *45*, 27–36. doi:10.1093/geront/45.suppl_1.27

Ewers, M., Frisoni, G. B., Teipel, S. J., Grinberg, L. T., Amaro, E. Jr., Heinsen, H., et al. (2011). Staging Alzheimer's disease progression with multimodality neuroimaging. *Progress in Neurobiology*, *95*, 535–546. doi:10.1016/j.pneurobio.2011.06.004

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, *12*, 189–198. doi:10.1016/0022-3956(75)90026-6

Foster, N. A., & Valentine, E. R. (2001). The effect of auditory stimulation on autobiographical recall in dementia. *Experimental Aging Research*, *27*, 215–228. doi:10.1080/036107301300208664

Garland, K., Beer, E., Eppingstall, B., & O'Connor, D. W. (2007). A comparison of two treatments of agitated behavior in nursing home residents with dementia: Simulated family presence and preferred music. *The American Journal of Geriatric Psychiatry*, *15*, 514–521.

Goldberg, D. P., & Williams, P. (1988). *The user's guide to the General Health Questionnaire*. Windsor, UK: NFER-Nelson.
Götell, E., Brown, S., & Ekman, S. L. (2003). Influence of caregiver singing and background music on posture, movement, and sensory awareness in dementia care. *International Psychogeriatrics/IPA*, *15*, 411–430.
Guétin, S., Portet, F., Picot, M. C., Pommié, C., Messaoudi, M., Djabelkir, L., et al. (2009). Effect of music therapy on anxiety and depression in patients with Alzheimer's type dementia: Randomised, controlled study. *Dementia and Geriatric Cognitive Disorders*, *28*, 36–46. doi:10.1159/000229024
Hall, C. B., Lipton, R. B., Sliwinski, M., Katz, M. J., Derby, C. A., & Verghese, J. (2009). Cognitive activities delay onset of memory decline in persons who develop dementia. *Neurology*, *73*, 356–361. doi:10.1212/WNL.0b013e3181b04ae3
Hanna-Pladdy, B., & MacKay, A. (2011). The relation between instrumental musical activity and cognitive aging. *Neuropsychology*, *25*, 378–386. doi:10.1037/a0021895
Hays, T., & Minichiello, V. (2005). The meaning of music in the lives of older people: A qualitative study. *Psychology of Music*, *33*, 437–451. doi:10.1177/0305735605056160
Herholz, S. C., & Zatorre, R. J. (2012). Musical training as a framework for brain plasticity: Behavior, function, and structure. *Neuron*, *76*, 486–502. doi:10.1016/j.neuron.2012.10.011
Hickok, G., Buchsbaum, B., Humphries, C., & Muftuler, T. (2003). Auditory-motor interaction revealed by fMRI: Speech, music, and working memory in area Spt. *Journal of Cognitive Neuroscience*, *15*, 673–682. doi:10.1162/jocn.2003.15.5.673
Hokkanen, L., Rantala, L., Remes, A. M., Härkönen, B., Viramo, P., & Winblad, I. (2008). Dance and movement therapeutic methods in management of dementia: A randomized, controlled study. *Journal of the American Geriatrics Society*, *56*, 771–772. doi:10.1111/j.1532-5415.2008.01611.x
Hyde, K. L., Lerch, J., Norton, A., Forgeard, M., Winner, E., Evans, A. C., et al. (2009). Musical training shapes structural brain development. *The Journal of Neuroscience*, *29*, 3019–3025. doi:10.1523/JNEUROSCI.5118-08.2009
Irish, M., Cunningham, C. J., Walsh, J. B., Coakley, D., Lawlor, B. A., Robertson, I. H., et al. (2006). Investigating the enhancing effect of music on autobiographical memory in mild Alzheimer's disease. *Dementia and Geriatric Cognitive Disorders*, *22*, 108–120. doi:10.1159/000093487
Janata, P. (2009). The neural architecture of music-evoked autobiographical memories. *Cerebral Cortex*, *19*, 2579–2594. doi:10.1093/cercor/bhp008
Janata, P., Tillmann, B., & Bharucha, J. J. (2002). Listening to polyphonic music recruits domain-general attention and working memory circuits. *Cognitive, Affective & Behavioral Neuroscience*, *2*, 121–140. doi:10.3758/CABN.2.2.121
Johnson, J. K., Chang, C. C., Brambati, S. M., Migliaccio, R., Gorno-Tempini, M. L., Miller, B. L., et al. (2011). Music recognition in frontotemporal lobar degeneration and Alzheimer disease. *Cognitive and Behavioral Neurology*, *24*, 74–84. doi:10.1097/WNN.0b013e31821de326
Juslin, P. N., & Sloboda, J. (Eds.) (2011). *Handbook of music and emotion: Theory, research, applications*. Oxford, England: Oxford University Press.
Kaplan, E., Goodglass, H., & Weintraub, S. (1983). *The Boston Naming Test*. Philadelphia, PA: Lea & Febiger.
Kattenstroth, J. C., Kolankowska, I., Kalisch, T., & Dinse, H. R. (2010). Superior sensory, motor, and cognitive performance in elderly individuals with multi-year dancing activities. *Frontiers in Aging Neuroscience*, *2*, e1–e9. doi:10.3389/fnagi.2010.00031
Kertesz, A. (1982). *The Western Aphasia Battery*. New York: The Psychological Corporation.
Kleber, B., Veit, R., Birbaumer, N., Gruzelier, J., & Lotze, M. (2010). The brain of opera singers: Experience-dependent changes in functional activation. *Cerebral Cortex*, *20*, 1144–1152. doi:10.1093/cercor/bhp177
Koelsch, S. (2010). Towards a neural basis of music-evoked emotions. *Trends in Cognitive Sciences*, *14*, 131–137. doi:10.1016/j.tics.2010.01.002
Koelsch, S., & Siebel, W. A. (2005). Towards a neural basis of music perception. *Trends in Cognitive Sciences*, *9*, 578–584. doi:10.1016/j.tics.2005.10.001
Kreutz, G., Bongard, S., Rohrmann, S., Hodapp, V., & Grebe, D. (2004). Effects of choir singing or listening on secretory immunoglobulin A, cortisol, and emotional state. *Journal of Behavioral Medicine*, *27*, 623–635.
Logsdon, R. G., Gibbons, L. E., McCurry, S. M., & Teri, L. (2002). Assessing quality of life in older adults with cognitive impairment. *Psychosomatic Medicine*, *64*, 510–519.
Mammarella, N., Fairfield, B., & Cornoldi, C. (2007). Does music enhance cognitive performance in healthy older adults? The Vivaldi effect. *Aging Clinical and Experimental Research*, *19*, 394–399. doi:10.1007/BF03324720
Morris, J. C., Heyman, A., Mohs, R. C., Hughes, J. P., van Belle, G., Fillenbaum, G., et al. (1989). The Consortium to Establish a Registry for Alzheimer's Disease (CERAD). Part I. Clinical and neuropsychological assessment of Alzheimer's disease. *Neurology*, *39*, 1159–1165. doi:10.1212/WNL.39.9.1159
Numminen, A. (2005). Laulutaidottomasta kehittyväksi laulajaksi: tutkimus aikuisen laulutaidon lukoista ja niiden aukaisemisesta [Helping adult poor pitch singers learn to sing in tune. A study of stumbling blocks confronting developing singers and means of surmounting them, doctoral dissertation]. Sibelius Academy, Helsinki (in Finnish).
Olazarán, J., Reisberg, B., Clare, L., Cruz, I., Peña-Casanova, J., del Ser, T., et al. (2010). Nonpharmacological therapies in Alzheimer's disease: A systematic review of efficacy. *Dementia and Geriatric Cognitive Disorders*, *30*, 161–178. doi:10.1159/000316119
Parbery-Clark, A., Strait, D. L., Anderson, S., Hittner, E., & Kraus, N. (2011). Musical experience and the aging auditory system: Implications for cognitive abilities and hearing speech in noise. *PLoS One*, *6*, e18082. doi:10.1371/journal.pone.0018082
Perry, D. W., Zatorre, R. J., Petrides, M., Alivisatos, B., Meyer, E., & Evans, A. C. (1999). Localization of cerebral activity during simple singing. *NeuroReport*, *10*, 3979–3984. doi:10.1097/00001756-199912160-00046
Prince, M., & Jackson, J. (Eds.) (2009). *World Alzheimer report 2009*. London: Alzheimer's Disease International.
Raglio, A., Bellelli, G., Traficante, D., Gianotti, M., Ubezio, M. C., Villani, D., et al. (2008). Efficacy of music therapy in the treatment of behavioral and psychiatric symptoms of dementia. *Alzheimer Disease and Associated Disorders*, *22*, 158–162. doi:10.1097/WAD.0b013e3181630b6f
Ready, R. E., Ott, B. R., Grace, J., & Fernandez, I. (2002). The Cornell-Brown Scale for Quality of Life in dementia. *Alzheimer Disease and Associated Disorders*, *16*, 109–115. doi:10.1097/01.WAD.0000013689.85676.F7
Reitan, R. M. (1958). Validity of the Trail Making test as an indicator of organic brain damage. *Perceptual & Motor Skills*, *8*, 271–276. doi:10.2466/PMS.8.7.271-276
Rickard, N. S., Toukhsati, S. R., & Field, S. E. (2005). The effect of music on cognitive performance: Insight from neurobiological and animal studies. *Behavioral and Cognitive Neuroscience Reviews*, *4*, 235–261. doi:10.1177/1534582305285869
Ridder, H. M. (2005). An overview of therapeutic initiatives when working with people suffering from dementia. In D. Aldridge (Ed.) *Music therapy and neurological rehabilitation* (pp. 61–82). London: Jessica Kingleys Publishers.
Romero-Moreno, R., Márquez-González, M., Mausbach, B. T., & Losada, A. (2012). Variables modulating depression in dementia caregivers: A longitudinal study. *International Psychogeriatrics/IPA*, *24*, 1316–1324. doi:10.1017/S1041610211002237
Särkämö, T., & Soto, D. (2012). Music listening after stroke: Beneficial effects and potential neural mechanisms. *Annals of the New York Academy of Sciences*, *1252*, 266–281. doi:10.1111/j.1749-6632.2011.06405.x
Särkämö, T., Tervaniemi, M., Laitinen, S., Forsblom, A., Soinila, S., Mikkonen, M., et al. (2008). Music listening enhances cognitive recovery and mood after middle cerebral artery stroke. *Brain*, *131*(Pt 3), 866–876. doi:10.1093/brain/awn013
Schneider, J., Murray, J., Banerjee, S., & Mann, A. (1999). EUROCARE: a cross-national study of co-resident spouse carers for people with Alzheimer's disease: I–Factors associated with carer burden. *International Journal of Geriatric Psychiatry*, *14*, 651–661. doi:10.1002/(SICI)1099-1166(199908)
Simmons-Stern, N. R., Budson, A. E., & Ally, B. A. (2010). Music as a memory enhancer in patients with Alzheimer's disease. *Neuropsychologia*, *48*, 3164–3167. doi:10.1016/j.neuropsychologia.2010.04.033
Skingley, A., & Bungay, H. (2010). The Silver Song Club Project: Singing to promote the health of older people. *British Journal of Community Nursing*, *15*, 135–140.
Sluming, V., Barrick, T., Howard, M., Cezayirli, E., Mayes, A., & Roberts, N. (2002). Voxel-based morphometry reveals increased gray matter density in Broca's area in male symphony orchestra musicians. *Neuroimage*, *17*, 1613–1622. doi:10.1006/nimg.2002.1288

Sung, H. C., Lee, W. L., Chang, S. M., & Smith, G. D. (2011). Exploring nursing staff's attitudes and use of music for older people with dementia in long-term care facilities. *Journal of Clinical Nursing*, *20*, 1776–1783. doi:10.1111/j.1365-2702.2010.03633.x

Thompson, R. G., Moulin, C. J., Hayre, S., & Jones, R. W. (2005). Music enhances category fluency in healthy older adults and Alzheimer's disease patients. *Experimental Aging Research*, *31*, 91–99. doi:10.1080/03610730590882819

Treiber, K. A., Carlson, M. C., Corcoran, C., Norton, M. C., Breitner, J. C., Piercy, K. W., et al. (2011). Cognitive stimulation and cognitive and functional decline in Alzheimer's disease: The cache county dementia progression study. *Journal of Gerontology: Psychological Sciences*, *66*, P416–P425. doi:10.1093/geronb/gbr023

Van de Winckel, A., Feys, H., De Weerdt, W., & Dom, R. (2004). Cognitive and behavioural effects of music-based exercises in patients with dementia. *Clinical Rehabilitation*, *18*, 253–260. doi:10.1191/0269215504cr750oa

Verghese, J., Lipton, R. B., Katz, M. J., Hall, C. B., Derby, C. A., Kuslansky, G., et al. (2003). Leisure activities and the risk of dementia in the elderly. *The New England Journal of Medicine*, *348*, 2508–2516. doi:10.1056/NEJMoa022252

Wechsler, D. (1997a). *Wechsler Adult Intelligence Scale (3rd ed.)*. San Antonio, TX: The Psychological Corporation.

Wechsler, D. (1997b). *Wechsler Memory Scale (3rd ed.)*. San Antonio, TX: The Psychological Corporation.

Wimo, A., & Prince, M. (2010). *World Alzheimer Report 2010*. London: Alzheimer's Disease International.

Working group appointed by the Finnish Medical Society Duodecim, Societas Gerontologica Fennica, the Finnish Neurological Society, Finnish Psychogeriatric Association, and the Finnish Association for General Practice. (2010). Memory disorders: Current care guidelines. Helsinki, Finland: Finnish Medical Society Duodecim. Retrieved from http://www.kaypahoito.fi

Zatorre, R. J., Chen, J. L., & Penhune, V. B. (2007). When the brain plays music: Auditory-motor interactions in music perception and production. *Nature reviews Neuroscience*, *8*, 547–558. doi:10.1038/nrn2152

Zendel, B. R., & Alain, C. (2012). Musicians experience less age-related decline in central auditory processing. *Psychology and Aging*, *27*, 410–417. doi:10.1037/a0024816