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The Impact of Music Therapy on Language Functioning in Dementia

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Dementias, such as Alzheimer's disease, include a progressive deterioration of language functioning. While some researchers have reported an increase in patients' self-expression following music therapy, it is not clear whether these changes specifically reflect improved language skills or whether simple interpersonal interaction with a therapist could account for the improvement. In this study, the effects of music therapy were compared to conversational sessions on language functioning in dementia patients. Participants were selected according to the following criteria: (a) residing in a facility specializing in Alzheimer's and related disorders; (b) possessing sufficient verbal ability to answer simple questions and to comply with requests to speak, participate, or sit down; and (c) attaining the written consent of the patient's guardian or representative. All participants had been in music therapy twice per week for at least 3 months prior to the study onset. One week prior to the beginning of the study, subjects were assessed for cognitive functioning using the Mini-Mental State Examination (MMSE), and language ability via the Western Aphasia Battery (WAB). A within-subjects design was used, with order of condition (music or group conversation first) counter-balanced between participants. Subjects participated in groups of 2 to 4, twice per week for 20–30 minutes for a total of 8 sessions (4 music therapy and

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4 conversation sessions or vice-versa), and were re-tested on the WAB at the end of each 2 week (4 session) interval. Results from 20 participants revealed that music therapy significantly improved performance on both speech content and fluency dimensions of the spontaneous speech subscale of the WAB (p = .01). While the difference in overall Aphasia Quotient (AQ) for music and conversation sessions (mean AQ = 76 vs. 70, respectively) did not reach statistical significance, data were only available for 10 participants (5 per condition). Hopefully, these findings will stimulate additional research on the use of music therapy interventions with demented patients, as it may offer a noninvasive mechanism to enhance communication between victims and their caregivers.

The incidence of dementia is rising steadily, in part due to the increase in average life expectancy observed over the last century (Khachaturian & Radebaugh, 1996). Although there are multiple causes of dementia, the most prevalent is dementia of the Alzheimer's type (DAT), followed by multi-infarct dementia and mixed Alzheimer's disease with multi-infarct dementia (Alzheimer's Disease and Related Disorders Association, 1990). It is well acknowledged that this population presents serious challenges in their everyday care, and although there is no cure, much can be done to ameliorate some of their deficits and improve their quality of life. Anecdotal evidence and informal reports by health care professionals and family members suggest that music and music therapy may have a unique effect on people with dementias, more specifically on those with a probable diagnosis of DAT (Cooper, 1991; Lloyd, 1992; Smith, 1992). Brotons, Koger, and Pickett-Cooper (1997) conducted an extensive review of literature published since 1985 in the area of music/music therapy and dementias and categorized, coded, and summarized the research outcomes. The results showed that music therapy appeared overall to be an effective intervention for dealing with a variety of dementia symptoms including decreased social/emotional skills, diminished cognitive ability and behavioral problems.

The deterioration of language abilities, including both comprehension and production, is a hallmark symptom of dementia (Appell, Kertesz, & Fisman, 1982; Cummings, Benson, Hill, & Read,

1985; Murdoch & Chenery, 1987). Although it appears that language impairment is present in all stages of dementia, the severity of the language disturbance may reflect the overall severity of the dementia (Morris, 1996; Swartz, Hantz, Crummer, Walton, & Frisina, 1989). The language disturbance presented by individuals with DAT appears to resemble other aphasias: anomic aphasia, transcortical sensory aphasia, Wernicke's aphasia and global aphasia (Mathews, Obler, & Albert, 1994). Fromm and Holland (1989) compared communicative abilities in daily living among elderly with mild and moderate DAT, elderly depressed, control elders, and elders with Wernicke's aphasia and described DAT individuals' language as irrelevant, vague and of rambling style. Patel and Satz (1994) state that as DAT progresses, language production consists mainly of prelearned, preprogrammed utterances used in conventional common situations. However, the language that relies heavily on cognitive processing such as reading, comprehending divergencies, utilizing context and using sequential relations suffers a progressive decline. It follows, therefore, that any treatment protocol aimed at ameliorating dementia symptoms should include language skills as a necessary (if not sufficient) indication of improvement.

Anecdotal reports and case studies suggest that music therapy offers a means of self-expression via musical performance or participation following various forms of brain-damage (O'Callaghan, 1993; Sacks & Tomaino, 1991) including dementia (Aldridge, 1995; Geula, 1986; Prickett & Moore, 1991; Whitcomb, 1994). Several investigators have described positive effects from music therapy on demented patients' verbalization and reminiscence (Sambandham & Schirm, 1995), recall of song lyrics (Prickett & Moore, 1991; Smith, 1990) and singing (Clair & Bernstein, 1990) however, it remains controversial whether these abilities recruit brain "language" centers such as those affected in aphasia (Aldridge, 1995). That is, musical ability may be functionally and anatomically dissociable from language (Polk & Kerstesz, 1993) and recent verbal memory (Crystal, Grober, & Masur, 1989). Cohen and Masse (1993) observed an improvement in purposive, conversational speech in patients of cerebrovascular accidents following rhythm and singing sessions. Likewise, Carruth (1997) noted improved naming following music therapy in elderly with memory loss. We know of no systematic evaluations of the nature and extent of improvement of specific language function in dementia following ad-

ministration of music therapy, nor have most reports on the efficacy of music therapy controlled for interaction with a therapist.

The present study sought to determine if music therapy affected language functioning. We utilized a reliable and valid measure of aphasia that has proven useful in distinguishing demented patients from normals (Appell et al., 1982; Horner, Dawson, Heyman, & McGorman Fish, 1992). We directly compared language performance following music therapy interventions versus conversational sessions without music to control for interpersonal contact with the therapist. Because participants had been receiving music therapy for 3 months prior to study inception, we anticipated a more conservative estimate of therapeutic effect as a result of a reduced experiential novelty effect and personal familiarity with the therapist.

Method

Participants

Twenty-six participants (18 female, 8 male, mean age 81) were recruited from a facility in the Northwest specializing in Alzheimer's care. Two subjects were mobile and the others were aided by wheelchairs. All participants were: (a) residents of a facility specializing in Alzheimer's and related disorders; (b) able to answer simple questions and to comply with requests to speak, participate in group activities, or sit down; (c) given written consent by their guardian or representative; and (d) participating in music therapy sessions for a minimum of 3 months, twice per week, prior to initiation of this study (see Table 1 for participant demographics). The following methods were initiated subsequent to that 3-month period.

Instruments

Cognitive functioning. Subjects' cognitive functioning was assessed prior to and 2 weeks following the treatment phases via the Mini-Mental State Exam (MMSE; Folstein, Folstein, & McHugh, 1975). The MMSE, a standardized test which takes approximately 10 minutes to administer, is a frequently cited diagnostic for dementia (see Ashford, Schmitt, & Kumar, 1998; Katzman, 1996).

Language performance. Subjects' communicative ability was evaluated by the Western Aphasia Battery (WAB; Kertesz, 1980), specifically by administering four subscales of the test: spontaneous

TABLE 1

Participant Demographic Information

		n		*M* (*SE*)
Gender:	female	15	age:	81.0 (1.3)
	male	05		78.6 (3.4)
Time in facility (months):				13.00 (1.0)
MMSE:	pretest	20		10.00 (1.0)
	posttest	18		10.44 (1.3)
MMSE level at pretest[1]	mild	1		
	moderate	12		
	severe	1		
	profound	6		

[1] Participant categorization based on Ashford, Schmitt, and Kumar (1998).

speech, auditory verbal comprehension, repetition, and naming. Evaluation occurred one week prior to and once during each intervention phase (described below). The administration of the four subscales takes approximately 25 minutes. This test was developed for both clinical and research applications (Kertesz, 1979) and has been used to assess language skills in people with dementias (Appell et al., 1982; Horner et al., 1992), as it represents an objective, standardized assessment of language that is minimally sensitive to education and intelligence and satisfies good reliability and validity criteria (Appell et al., 1982; Kertesz, 1979). For this project, the WAB was administered once prior to the beginning of the treatment phases and twice during treatment (once after each four session block of music or conversation, with the order of condition counterbalanced across participants). Subjects were audiotaped while taking the WAB for later coding and analysis. Three of the four subscales (auditory verbal comprehension, repetition, and naming) were scored by two independent analysts. Any disagreements in scoring were readily resolved by discussion. Because of the subjectivity involved in scoring the spontaneous speech subsection, a transcription was made from the audiotapes. Three independent analysts who were blind to the subjects' condition (e.g., order of treatment as well as mental status and performance during testing) listened to the tape while reading the transcription and assigned scores. The numeric mean of the 3 observers' ratings was used for

analyses of the content and fluency of spontaneous speech. An overall Aphasia Quotient (AQ) was derived according to Kertesz (1979) for subjects completing all subscales.

Design and Procedures

During the treatment phase, subjects participated in groups of two to four members, twice per week for 30 minutes. A total of eight therapy sessions were administered in block of four, providing 2 weeks per condition (music or conversation). Condition order was counterbalanced between participants, with music sessions given first to half of the subjects (selected randomly) and conversation first to the remainder. Different topics were chosen for each session: animals, flowers, spring, and either St. Patrick's day or the United States depending on the month in which the sessions took place. Pictures and photographs were used to stimulate discussion and reminiscence during the conversational sessions. For the music therapy sessions, songs addressing each of the four topics were sung (with guitar accompaniment) to introduce and provide structure for subsequent discussion and conversation about the topic. The songs chosen for each of the topics were as follows:

1. Animals: *Home on the Range, Camptown Races, Old MacDonald Had a Farm, BINGO.*
2. Flowers: *Yellow Rose of Texas, My Wild Irish Rose, When You Were a Tulip, Daisy Bell.*
3. Spring: *It's Springtime in the Rockies, Let Me Call You Sweetheart, Take Me Out to the Ball Game, Singing in the Rain.*
4. St. Patrick's: *My Wild Irish Rose, When Irish Eyes are Smiling, Danny Boy, I'm Looking Over a Four Leaf Clover.*
5. United States: *This Land is Your Land, My Old Kentucky Home, Oh Susanna, Deep in the Heart of Texas.*

The music sessions started with a hello song in which everyone was given a chance to introduce themselves. It was followed by the first topical song, and then questions were asked to prompt conversation and discussion. The same procedure was followed for each of the songs, and all songs were sung twice. Each song was accompanied by pictures of the items named in the songs. The session concluded with a goodbye song. The conversation sessions followed the same format but without any music. All sessions took place in the morning in an activities room free of external distractions or interruptions and were led by the same music therapy intern.

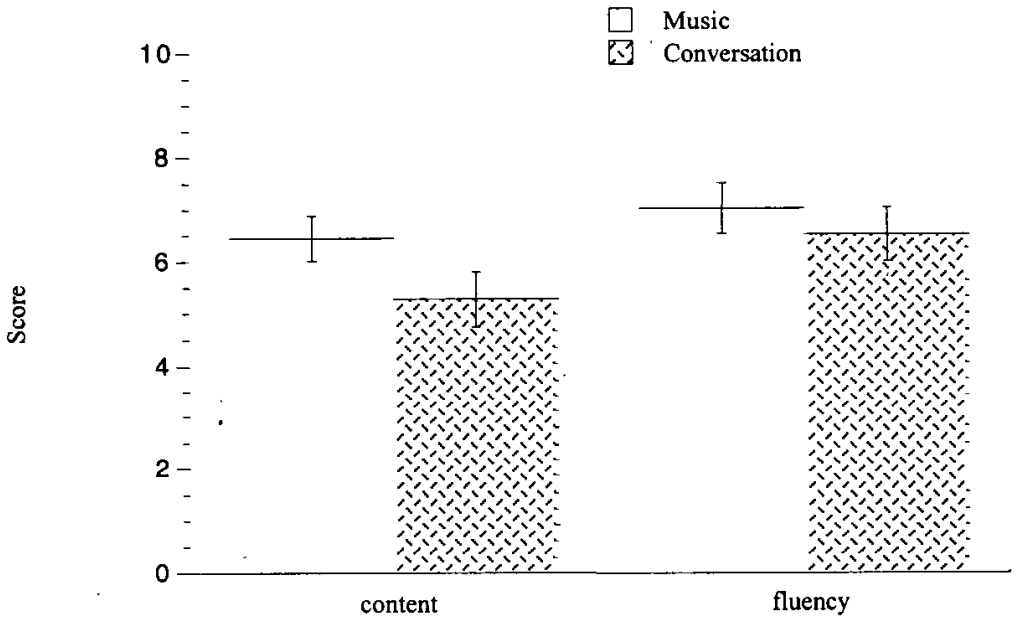

FIGURE 1.
Overall performance on content and fluency in music versus conversation conditions.

Results

Analyses were restricted to 20 participants who completed at least the first subtest of the WAB (spontaneous speech), providing a measure of speech content and fluency. The mean inter-rater reliability among the three independent judges for this subscale was greater for content ($r = .88$) than for fluency ($r = .7$)[1]. Preintervention MMSE and spontaneous speech rated for content were significantly correlated ($r = .871$, $p = .0001$).

A two-way repeated measures revealed significant main effects for condition (music versus conversation, $F(1,19) = 7.4$, $p = .01$, and speech content versus fluency, $F(1,19) = 10.581$, $p = .004$), with performance better in music relative to conversation and fluency relative to content (see Figure 1). The interaction term approached but did not reach significance ($p = .09$), suggesting that performance during the music condition was better than conversation sessions for both speech content and fluency. Of the 20 participants in the preceding analyses, 19 also completed the first section

[1] This pattern for inter-rater reliability (content greater than fluency) is consistent with Kertesz's (1979) findings.

TABLE 2

Language Performance

Subscale of WAB	*n*		*M* (*SE*)
Spontaneous speech[1]	20	music	6.74 (0.3)
	20	conversation	5.91 (0.4)[3]
Auditory comprehension[2] (yes/no questions)	19	music	7.66 (0.4)
	19	conversation	7.82 (0.4)

[1] Each subtest based on a maximum of 10 points.

[2] This section includes 20 questions, scored for a maximum of 60 points. Patients' scores were divided by 6 to attain scaling comparable to that of spontaneous speech (i.e., a maximum of 10 per section).

[3] $p = .01$.

of the auditory verbal comprehension subscale of the WAB (yes/no questions). A 1-way ANOVA indicated that music and conversation groups did not differ on this subscale ($p > .1$; see Table 2 for descriptive statistics).

An effect size estimate for overall Aphasia Quotient was used rather than ANOVA because of the small sample size (5 per condition[2]). The means were in the hypothesized direction (69.9 versus 76.2, pooled standard deviation = 11.89), and yielded an effect size, $r = .257$ that was not statistically significant ($p > .1$).

A one-factor ANOVA on MMSE before and 2 weeks posttreatment on 18 subjects who were available at posttest demonstrated no significant change during the course of the study ($p > .1$).

Discussion

Our results demonstrated that speech content and fluency as assessed by the spontaneous speech subscale of the WAB were better following music therapy than conversational sessions with a therapist. Consistent with previous reports, fluency (ease and quantity of production) appears to be preserved longer than content in persons with DAT (Appell et al., 1982; Murdoch & Chenery, 1987), although our findings suggest that both aspects may be sensitive to the effects of music. The obtained effect size for overall Aphasia

[2] Due to a clerical error, data for the entire comprehension, repetition, and naming subscales from the first testing session (the same 10 subjects in the alternate conditions) were unavailable for analysis.

Quotient differences between conditions (.257) is small to moderate, but because of the potential clinical significance of musical interventions, should not be overlooked without further empirical evaluation. In fact, it has been suggested that an effect size estimate of this magnitude reflects a large, practical effect (i.e., an increase in performance from $r = .38$ to .62 for conversation versus music sessions, respectively) when interpreted via the binomial effect-size display (Rosenthal & Rosnow, 1991, p. 282). Thus, the lack of a statistically significant difference between music and conversational conditions in overall Aphasia Quotient may be attributable to the limited number of subjects included in the analysis rather than there being no difference between the types of interaction on overall language ability (including comprehension, repetition and naming). However, an effect of musical intervention on content and fluency but not comprehension, for example (based on data for spontaneous speech and the first section of the auditory comprehension subscales), would be interesting in its own right.

The significant correlation between baseline MMSE and spontaneous speech ratings for content seems in line with reports that the severity of the language disturbance may reflect the overall severity of the dementia (Morris, 1996; Swartz et al., 1989). The lack of a significant change between pre and posttreatment MMSE may reflect a relative lack of decline over the course of the study; however, the absence of two participants at posttreatment evaluation hinders interpretation of this result.

It is unclear whether the purported effect of music on language production is direct or indirect via short-term memory activation. Appell et al. (1982) postulated that language may become emptier in persons with DAT because of short-term memory deficits, reflected by an increase in perseverations. To the best of our knowledge, no other studies have documented the specific effects of music on language skills in DAT; however, improved recall of verbal material when presented in a musical context were previously reported (Prickett & Moore, 1991). Whatever function music may affect (short-term memory or language), our results included perceptibly positive effects on speech.

An underlying mechanism for the putative relationship between exposure to music and amelioration of cognitive deficits in DAT is not understood. Reviews of the neurological literature suggest that the anatomical substrates of verbal and musical abilities are disso-

ciable, evidenced by the incidence of aphasia without amusia and amusia without aphasia (e.g., Marin, 1982; Sergent, 1993; see also recent reports by Peretz et al., 1994; Polk & Kertesz, 1993; Takahashi et al., 1992), although the two disorders have also been reported to coexist (Hofman, Klein, & Arlazoroff, 1993; see also review by Marin, 1982). Specifically with regard to DAT, there are reports of patients continuing to sing old songs despite aphasia and memory loss (Braben, 1992), and of preserved ability to perform musically while being unable to identify the composer or titles of the work (Beatty et al., 1988; Crystal, Grober, & Masur, 1989), possibly because performance represents an "overlearned or automated task" (Marin, 1982, p. 467). This possibility was considered by Beatty et al. (1988) who interpreted the DAT deficit as one of anterograde recall, recognition and remote memory, whereas motor skills remain intact. Such distinctions between so-called *declarative and procedural memory* have been also observed in amnesics (Cohen & Squire, 1980). It is tempting to conclude that a hierarchical view, wherein declarative knowledge is viewed as more complex or evolutionarily recent than procedural memory (Squire, 1987), may account for the dissociation between memory and performance observed in DAT. This view may also aid in interpreting the palliative role of music; for example, that music taps into more "primitive" anatomical structures such as those involved in emotional experience, or that music can "stimulate and organize higher mental functions, especially when these have been damaged by disease" (Sacks & Tomaino, 1991, p. 11). Others have postulated a differential lateralization of music and language with relatively greater right and left hemispheric involvement, respectively (Polk & Kertesz, 1993), or a differentiation between receptive amusia which often follows left hemisphere lesions and "expressive, especially instrumental amusia" following right hemisphere damage (Wertheim, 1969, p. 204). If that is the case, it is unclear how music would impact language functioning, although it may reflect the overlapping substrates for auditory perception in both musical and language domains.

Overall, our results suggest that music therapy interventions may positively influence the speech content and fluency in people affected by DAT. Many clinical and empirical questions remain with respect to the potential for music therapy interventions to affect cognitive functioning:

1. Are other aspects of the aphasic disturbance in DAT similarly affected by music, or are certain language functions irreversibly damaged because of the disease?
2. Do music therapy interventions affect language by stimulating more accurate sentence reconstruction?
3. Do music therapy interventions hold the attention of DAT patients longer than simple conversation groups? If so, DAT patients may become more oriented within the therapeutic session and thus more responsive in their spontaneous speech. It was noted informally that because participants in the music groups were more talkative than those in the conversation condition, music sessions tended to last somewhat longer. Further, fewer patients left the music groups before their completion. While this may present an interpretive difficulty with respect to session length, it seems clear that the temporal relationship allows a causal deduction: increased communicativeness led to longer sessions, rather than vice versa.
4. Is the improvement in speech content attributable to an effect on short-term memory?
5. How long do the putative effects of music therapy on language last?

Certainly, more research in the area of music therapy effects on language functioning in persons affected by DAT are needed. Therapeutic implications, including the preservation and enhancement of communication between patients and their caregivers, friends and family members, are profound.

References

Aldridge, A. (1995). Music therapy and the treatment of Alzheimer's disease. *Clinical Gerontologist, 16,* 41–57.

Alzheimer's Disease and Related Disorders Association. (1990). Alzheimer's disease statistics (ED 2302). Chicago, IL: ADRDA.

Appell, J., Kertesz, A., & Fisman, M. (1982). A study of language functioning in Alzheimer patients. *Brain and Language, 17,* 73–91.

Ashford, J. W., Schmitt, F., & Kumar, V. (1998). Diagnosis of Alzheimer's disease. In V. Kumar & C. Eisdorfer (Eds.), *Advances in the diagnosis and treatment of Alzheimer's disease* (pp. 111–151). New York: Springer.

Beatty, W. W., Zavadil, K. D., Bailly, R. C., Rixen, G. J., Zavadil, L. E., Farnham, N., & Fisher, L. (1988). Preserved musical skill in a severely demented patient. *International Journal of Clinical Neuropsychology, 10*(4), 158–164.

Braben, L. (1992). A song for Mrs. Smith. *Nursing Times, 88*(41), 54.

Brotons, M., Koger, S., & Pickett-Cooper, P. (1997). Music and dementias: A review of literature. *Journal of Music Therapy, 34,* 204–245.

Carruth, E. K. (1997). The effects of singing and the spaced retrieval technique on improving face-name recognition in nursing home residents with memory loss. *Journal of Music Therapy, 34,* 165–186.

Clair, A., & Bernstein, B. (1990). A preliminary study of music therapy programming for severely regressed persons with Alzheimer's-type dementia. *Journal of Applied Gerontology, 9*(3), 299–311.

Cohen, N. J., & Squire, L. R. (1980). Preserved learning and retention of pattern-analyzing skill in amnesia: Dissociation of knowing how and knowing that. *Science, 210,* 207–210.

Cohen, N. S., & Masse, R. (1993). The application of singing and rhythmic instruction as a therapeutic intervention for persons with neurogenic communication disorders. *Journal of Music Therapy, 30*(2), 81–99.

Cooper, J. (1991). Songs that soothe. *New Zealand Nursing Journal, 84*(3), 22–23.

Crystal, H. A., Grober, E., & Masur, D. (1989). Preservation of musical memory in Alzheimer's disease. *Journal of Neurology, Neurosurgery and Psychiatry, 52,* 1415–1416.

Cummings, J. L., Benson, D. F., Hill, M. A., & Read, S. (1985). Aphasia in dementia of the Alzheimer type. *Neurology, 25,* 394–397.

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.

Fromm, D., & Holland, A. L. (1989). Functional communication in Alzheimer's disease. *Journal of Speech and Hearing Disorders, 54,* 535–540.

Geula, M. S. (1986). Activities for AD: Music encourages self-expression. *Alzheimer's Disease and Related Disorders Newsletter, 6*(2), 7.

Hofman, S., Klein, C., & Arlazoroff, A. (1993). Common hemisphericity of language and music in a musician: A case report. *Journal of Communication Disorders, 26,* 73–82.

Horner, J., Dawson, D. V., Heyman, A., & McGorman Fish, A. (1992). The usefulness of the Western Aphasia Battery for differential diagnosis of Alzheimer dementia and focal stroke syndromes: Preliminary evidence. *Brain and Language, 42,* 77–88.

Katzman, R. (1996). Current research on Alzheimer's disease in a historical perspective. In Z. S. Khachaturian & T. S. Radebaught (Eds.), *Alzheimer's disease: Cause(s), diagnosis, treatment and care* (pp. 15–29). Boca Raton, FL: CRC Press.

Kertesz, A. (1979). *Aphasia and associated disorders: Taxonomy, localization and recovery.* New York: Grune & Stratton.

Kertesz, A. (1980). *Western Aphasia Battery.* London, Canada: University of Western Ontario.

Khachaturian, Z. S., & Radebaugh, T. S. (1996). Synthesis of critical topics in Alzheimer's disease. In Z. S. Khachaturian & T. S. Radebaugh (Eds.), *Alzheimer's disease: Cause(s), diagnosis, treatment and care* (pp. 3–12). Boca Raton, FL: CRC Press.

Lloyd, S. (1992). Finding the key: Nursing narratives. *Nursing Times, 88*(32), 48.

Marin, O. S. M. (1982). Neurological aspects of music perception and performance. In D. Deutsch (Ed.), *The psychology of music* (pp. 453–477). New York: Academic Press.

Mathews, P. J., Obler, L. K., & Albert, M. L. (1994). Wernicke and Alzheimer on the language disturbances of dementia aphasia. *Brain and Language, 46,* 439–462.

Morris, J. C. (1996). Diagnosis of Alzheimer's disease. In Z. S. Khachaturian & T. S. Radebaugh (Eds.), *Alzheimer's disease: Cause(s), diagnosis, treatment and care* (pp. 75–84). Boca Raton, FL: CRC Press.

Murdoch, B. E., & Chenery, H. J. (1987). Language disorders in dementia of the Alzheimer type. *Brain and Language, 31,* 122–137.

O'Callaghan, C. C. (1993). Communicating with brain-impaired palliative care patients through music therapy. *Journal of Palliative Care, 9,* 53–55.

Patel, P. G., & Satz, P. (1994). The language production system and senile dementia of Alzheimer's type: Neuropathological implications. *Aphasiology, 8*(1), 1–18.

Peretz, I., Kolinsky, R., Tramo, M., Labrecque, R., Hublet, C., Demeurisse, G., & Belleville, S. (1994). Functional dissociations following bilateral lesions of auditory cortex. *Brain, 117,* 1283–1301.

Polk, M., & Kertesz, A. (1993). Music and language in degenerative disease of the brain. *Brain and Cognition, 22,* 98–117.

Prickett, C. A., & Moore, R. S. (1991). The use of music to aid memory of Alzheimer's patients. *Journal of Music Therapy, 28*(2), 101–110.

Rosenthal, R., & Rosnow, R. L. (1991). *Essentials of behavioral research: Methods and data analysis.* New York: McGraw Hill.

Sacks, O., & Tomaino, C. (1991). Music and neurological disorder. *International Journal of Arts Medicine, 1*(1), 10–12.

Sambandham, M., & Schirm, V. (1995). Music as a nursing intervention for residents with Alzheimer's disease in long-term care. *Geriatric Nursing, 16*(2), 79–83.

Sergent, J. (1993). Music, the brain and Ravel. *Trends in Neurosciences, 16*(5), 168–172.

Smith, B. B. (1992). Treatment of dementia: Healing through cultural arts. *Pride Institute Journal of Long Term Home Health Care, 11*(3), 37–45.

Smith, S. (1990). The unique power of music therapy benefits Alzheimer's patients. *Activities, Adaptation and Aging, 14*(4), 59–63.

Squire, L. R. (1987). *Memory and brain.* New York: Oxford University Press.

Swartz, K. P., Hantz, E. C., Crummer, G. C., Walton, J. P., & Frisina, R. D. (1989). Does the melody linger on? Music cognition in Alzheimer's disease. *Seminars in Neurology, 9*(2), 152–158.

Takahashi, N., Kawamura, M., Shinotou, H., Hirayama, K., Kaga, K., & Shindo, M. (1992). Pure word deafness due to left hemisphere damage. *Cortex, 28,* 295–303.

Wertheim, N. (1969). The amusias. In P. J. Vinken & G. W. Bruyn (Eds.), *Disorders of speech, perception, and symbolic behavior* (pp. 195–206). New York: American Elsevier.

Whitcomb, J. B. (1994). "I would weave a song for you": Therapeutic music and milieu for dementia residents. *Activities, Adaptation and Aging, 18*(2), 57–74.