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The Impact of Singing Engagement on Food Intake of Individuals with Alzheimer's Disease and Related Dementias:

A Multi-site, Repeated Measures Study

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Abstract

Malnutrition among older adults with Alzheimer's disease and related dementias (ADRD) is a serious and long-recognized health concern. Identifying nonpharmacological means for enhancing the volume of nutrition intake is an urgent need. Researchers have explored the use of music and music therapy as nonpharmacological avenues in this regard, but most music-based studies related to food intake focus on receptive interventions wherein participants are exposed to recorded music during meal times. The purpose of the present research is to investigate whether residents with ADRD would significantly increase their volume of food intake during the midday meal immediately following 30 minutes of active singing engagement facilitated by a board-certified music therapist (MT-BC). Results indicated no significant change in food intake for participants with ADRD in three long-term care facilities. However, the unintended finding at two facilities wherein participants' food intake was greater during baseline weeks versus treatment weeks led to speculation about the impact of serotonin which researchers report is released during enjoyable music engagement episodes, but that has also long been recognized as an appetite suppressant. With this newly interpreted finding, recommendation is offered for monitoring when music therapy is provided for individuals with ADRD and nutritional complications relative to their meal times toward minimizing potential adverse effects.

Keywords: *singing, dementia, nutrition, serotonin, appetite, music therapy*

Introduction

Malnutrition among older adults with Alzheimer's disease and related dementias (ADRD) is a serious and long-recognized health concern (Amella et al., 2008; Lin et al., 2010; van Ort & Phillips, 1995; Volkert et al., 2018). Identifying nonpharmacological means for enhancing the volume of nutrition intake for persons with ADRD is an urgent need (Dyer et al., 2018; Jansen et al., 2015; Laver et al., 2016; Prince et al., 2014).

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Researchers have explored the use of music and music therapy as nonpharmacological avenues in this regard. However, systematic reviews and meta-analyses of studies exploring the impact of music-based interventions to ameliorate dementia symptoms reveal mixed results, most often due to low numbers of participants and poor methodological integrity (Laver et al., 2016; Petrovsky et al., 2015; van der Steen et al., 2018; Ueda et al., 2013).

Most music-based studies related to food intake focus on *receptive* interventions, in which participants are exposed to recorded music in the dining area during meal times (Ragneskog et al.,1996; Richeson & Neill, 2004; Thomas & Smith, 2009; Wong et al., 2008). In only one report did researchers engage residents with ADRD in *active* music making just prior to dining toward stimulating food intake during the meal (McHugh et al., 2012). McHugh and colleagues reported encouraging results but also cautious interpretation of their findings due to problematic data collection procedures. The researchers end their report by encouraging replication research applying careful method modifications.

The present study replicates many aspects of McHugh et al. (2012) but with several design modifications to increase overall methodological integrity. The purpose was to investigate whether residents with ADRD would significantly increase their volume of food intake during the midday meal immediately following 30 minutes of singing engagement facilitated by a board-certified music therapist (MT-BC). McHugh and colleagues reported that the older adults with ADRD with whom they worked demonstrated enhanced cognitive and social functioning along with positive changes in affect and physical energy immediately following music therapy sessions. These authors also drew on Aldridge's (2007) observation that songs can have "regulative effects" on functioning for both anxious and disorganized individuals and those with diminished arousal and cognitive functioning (p.31). With these observations and McHugh and colleagues' preliminary findings, it was hypothesized that the cognitive, physical, emotional, and social stimulation that residents experience during therapist-facilitated singing would yield significant increases in food intake as compared with usual care. Hereafter, "food intake" refers to the consumption of both solid foods and liquids.

Review of Literature

ADRD and Malnutrition

Key to maintaining a satisfactory level of physical and mental health in the face of unavoidable decline characteristic of ADRD is independently taking in adequate amounts of food during mealtimes. Volkert and co-authors (2018) emphasize that "Nutrition is an important modulator of health and well-being in older adults" (p. 2). Those with ADRD are at greater risk for malnutrition, with risk factors that include "the older person's social, economic and environmental situations; problems with mouth, teeth and swallowing; mental, neurological and other chronic physical diseases; and side effects of long-term treatment with certain drugs" (Prince et al., 2014, p. 6). Other factors include compromised taste sense, impaired planning (i.e., executive function), loss of interest in food, and lack of attention to the eating process (Brooke & Ojo, 2015; Suma et al., 2018). Anxiety and depression, which are common among persons with ADRD, are also related to poor nutritional intake (Amella et al., 2008). Malnutrition can result in frailty, reduced mobility, increased risk of falls and fractures, serious health conditions, and increased mortality (Prince et al., 2014). Evidence-based environmental and nonpharmacological interventions thought to maximize the potential for adequate food intake, including music in some form, have received considerable attention in the literature.

Music Listening as Nonpharmacological Intervention for Problem Behaviors During Mealtime

A recent systematic review of music-based interventions for persons with dementia provides the most up-to-date information about the potential impact of music in dementia care (van der Steen et al., 2018). The researchers analyzed 22 studies; unfortunately, neither malnutrition nor problematic weight loss were identified outcome measures. However, in describing music's impact, the authors wrote, "Music may also be used in ways which are less obviously therapy or therapeutic, for example, playing music during other activities, such as meals or baths…" (p. 6).

Multiple researchers have explored the use of recorded music as an environmental additive to ameliorate agitation and aggressive behaviors during mealtimes. Using adaptations of the Cohen-Mansfield Agitation Inventory (CMAI), they measured physical and verbal aggressive behavior and physical and verbal non-aggressive behavior. Findings are inconsistent, with one study (Ho et al., 2011) reporting a significant decrease in all four behaviors, one (Chang et al., 2010) pointing to a significant decrease in physical and verbal aggressive behavior (but no change in physical and verbal non-aggressive behavior), and one (Hicks-Moore, 2005) noting positive trends on all measures but no significant change. It should be noted that it was not these researchers' intent to test the impact of music on nutritional intake; rather, the purpose was to identify whether recorded music played in the dining environment could mitigate challenges that adversely impact facility staff. Nonetheless, it seems reasonable to assert that a less chaotic or distracting environment, promoted when agitation is reduced, might also be conducive to more productive eating for residents with ADRD.

Music Listening as Nonpharmacological Intervention for Increasing Food Intake

Authors noted the positive potential of background music in the dining environment as a nonpharmacological intervention for feeding difficulties of older adults with ADRD. In a study of older adults in Sweden, Ragneskog and colleagues (1996) found a 22% increase in length of time that residents spent in the dining room when various styles of music were played, with the longest time in response to "soothing" music and the second longest time with "popular Swedish" music. The researchers also reported positive changes during music interventions with regard to mood, agitation, and a decrease in the rate of speed at which residents ate their meals.

Richeson and Neill (2004) played recorded "relaxing" or "quiet" music in the dining area and evaluated agitation behaviors using the CMAI. Food intake was measured by calculating the difference between nursing staff estimates of percentage of food eaten during baseline and treatment phases. The researchers reported improvement in most of the agitation category scores and an 8.6% increase in estimated food intake.

Wong and colleagues (2008) used a multi-phase series of interventions to enhance nutritional intake of persons with ADRD who were admitted to a hospital assessment unit. The phases were baseline, encouragement of "dietary grazing," extended staff assistance, and playing recorded "soothing" music. Researchers measured a variety of dietary concerns including each individual's weight, body mass index, a malnutrition questionnaire, an Eating Behavior Scale, and a staff "plate waste measure" indicating the difference between the estimated amount of food served and the amount left after the meal (p. 310). Caloric intake at lunchtime was reported to have significantly increased during the music phase. Interestingly, overall food intake decreased with music played during breakfast, and patients remained in the dining area longer when music was present.

Thomas and Smith (2009) used a non-randomized, time-series crossover (ABAB) design to study the impact of background music to increase caloric intake. Twelve individuals served as their own controls. Food intake was measured using a visual estimation system of quartiles (i.e., 0%, 25%, 50%, 75%, 100%) of food consumed. Record-

ed music including popular classical compositions, traditional American, English, and Irish folk melodies, and 13th century English dance music was played in the dining area alternately for 8 weeks. Results showed an overall increase in caloric intake of 20% during weeks with music versus weeks with no music. Residents also stayed longer in the dining area when music was present, thereby enhancing the potential for continued eating and social interactions.

Singing as Nonpharmacological Intervention for Increasing Food Intake

Researchers from within and outside of music therapy have examined the health and mental health benefits derived from singing for adults in latter stages of life, including those with ADRD (Clements-Cortés, 2004,, 2017; Coulton et al., 2015; Lesta & Petocz, 2006). However, only one study was found that sought a connection between singing and improved food intake. McHugh and colleagues (2012) facilitated residents singing of familiar songs just prior to their midday meal to ascertain whether this form of active music engagement might stimulate increased food intake. These researchers highlighted the potential of singing engagement to "compose and soothe individuals who are disorganized or anxious and arouse those with abnormally diminished levels of physical and cognitive activity" (p. 32). This observation, coupled with the "regulative effects" of song as noted by Aldridge (2007, p.31), led the authors in this study to hypothesize that residents would be physically and emotionally better positioned to consume more food immediately following singing sessions versus controls who had no music engagement. Familiar popular, patriotic, and religious songs were carefully identified for the treatment group and food intake was measured through a visual plate waste quartiles system already in place at the facility. Results indicated no significant positive or negative changes in food intake for the treatment group as a whole while the mean food intake for the control wait-list group on treatment days was greater than for the treatment group. It was identified, however, that some of the residents in the treatment group increased their food consumption by 5%.

Purpose

Leah's (2016) systematic review of nonpharmacological interventions to enhance food intake included reviews of the Richeson and Neil (2004), Thomas and Smith (2009) and McHugh, et al. (2012) studies, and noted that only the receptive music experiences seemed to provide a positive influence on the volume of food intake. However, Leah had only McHugh et al's pilot study for comparison of singing with listening. The impact of singing, therefore, seems an important yet underdeveloped area of research relative to food intake. Leah's findings, therefore, serve as one impetus for the present research on an active versus receptive music intervention. A further motivation for this study is the general need for replication research in the music therapy literature as well as research on singular method variations (rather than on a variety of interventions typically facilitated during sessions), as called for in the proceedings of the AMTA sponsored symposium titled, *Improving access and quality: Music therapy research 2025* (AMTA, 2015). The purpose of the present study was to investigate the impact of 30 minutes of singing engagement facilitated by an MT-BC on the subsequent volume of food intake during the midday meal for individuals with ADRD.

Method

In the present inquiry, modifications to the methods employed by McHugh et al. (2012) included a more rigorous repeated-measures return to baseline design, multisite involvement toward a larger sample size, and more consistent data collection practices along with greater precision and objectivity in calculating food intake. The facilities where the study took place are located in the midwestern United States.

Table 1
Demographics of Study Participants

	Site 1	Site 2	Site 3
Number of Participants	M=4 F=6	M=3 F=5	M=0 F=10
Race	AA=5 Wh=5	AA=0 Wh=8	AA=0 Wh=10
MMSE Score (Range)	3–18	0–17	5–10

Note. M = Male, F = Female, AA = African American, Wh = White.
Scores on the Mini-Mental State Exam or MMSE indicate a level of impairment related to dementia as follows: 20–24 suggests mild dementia, 13–20 suggests moderate dementia, and less than 12 suggests severe dementia (Alzheimer's Association, 2020).

Study Design

This study used a repeated-measures (within-subjects) experimental design with participants serving as their own controls to measure the effectiveness of group singing on volume of food intake during the midday meal. Participants' food intake was measured three days per week at each of three sites for 4 weeks:

- Week 1 – Baseline (usual care, no singing)
- Week 2 – Treatment (group singing facilitated by an MT-BC)
- Week 3 – Baseline
- Week 4 – Treatment

Participant Selection and Eligibility Criteria

Participant selection occurred in coordination with each site's chief administrator and the directors of nursing and of dietetics with input from the director of social work at sites 1 and 3 and the activity director at site 2. Twenty-nine study participants with a primary diagnosis of ADRD were selected from a convenience sample of residents from all sites whose legally authorized representative (LAR) provided written consent for participation and who met the following additional eligibility criteria: (a) 50 years of age or older, (b) hearing adequate for engaging in active group singing, and (c) considered *self-feeders* by facility staff. A self-feeder was defined as an individual who fed them self with hands and utensils (i.e., brought food and drink to their own mouth). However, it was considered typical of the dining routine in all three facilities for staff to periodically use hand-over-hand assistance to lift food to a participant's mouth or for staff themselves to lift food to a participant's mouth, but such instances were rare. It was also considered typical for staff to provide periodic verbal reminders or redirection to a participant to sustain feeding when episodes of distraction occurred. One participant experienced profound deterioration during the study, making one-on-one feeding assistance necessary. This participant's data was nonetheless included in the study as she consistently attended and participated in the music engagement sessions and seemed able to respond to the aide responsible for her feeding to voluntarily open her mouth to ingest food and to refuse additional food when it seemed she was sated. One participant self-selected out of the study. Thus, a total of 28 residents ranging in age from 63 to 99 years completed the study. At two of the three sites, non-participant residents joined the study participants during singing; however, data were not collected for these residents as they did not meet all study eligibility criteria. The study was reviewed and approved by the Institutional Review Board of the primary investigator's (PI) institution and by the chief administrator at each facility. Specific demographic data for participants at each facility appears in Table 1.

Table 2
Site Details

	Site 1	Site 2	Site 3
Location	Urban	Suburban	Suburban
Categorization of Care	Skilled Nursing Care	Skilled Nursing Care	Skilled Nursing Care
Total Resident Capacity	99	169	54
Total Memory Support Capacity	NA	32	22
Total Study Participants	10	8	10
Intervention (Singing) Environment	Enclosed, multi-use activity room with windows overlooking hallway/nurses' station and windows overlooking site grounds; participants sat in chairs or wheelchairs around 6-foot long tables arranged end to end for family-style dining; flat-screen TV on one wall.	Enclosed, multi-use activity room with windows overlooking site grounds on two walls; participants sat in chairs or wheelchairs at square tables widely distributed throughout the room (max. 4 residents per table).	Open living room area adjacent to the dining room (see below); no windows; participants sat on a large couch, two over-sized chairs, or wheelchairs; flat screen TV on one wall.
Data Collection (Dining) Environment	Same space as the intervention environment described above.	Same space as the intervention environment described above.	Enclosed dining room with one large bay window overlooking site grounds; participants sat at combination of freestanding square tables (max. 3 residents) and one longer table (max. 6 residents).

Research Sites

Four nursing facilities where older adults with ADRD reside were approached by the PI with an invitation to participate in the study. Three sites responded affirmatively to the invitation. Descriptions of each participating site and the data collection environment appear in Table 2.

Treatment Conditions

Baseline

Baseline data were collected on Tuesday, Wednesday, and Thursday of Week 1 and Week 3 and represented *usual care*. Usual care received by residents during the 30 minutes prior to the midday meal varied by site and included recorded or radio music playing in the environment, television, and free, unstructured time. None of the sites held structured activity sessions led by staff during this period.

Thirty minutes prior to the meal, participants at Site 1 were consistently seated at the family-style table where they ate their meals. A large-screen television in immediate proximity played a game show until food trays arrived. At Site 2, most of the participants were seated 30 minutes before the meal at their assigned tables. Periodically, a radio played traditional country and rockabilly music by singers such as Hank Williams, Patsy Cline, Roger Miller, and Elvis Presley at a low volume level. (It was often questionable to the PI and research assistants whether the residents in the space could hear the radio due to its low volume level.) Participants at Site 3 were either

Table 3
MT-BC Characteristics and Site Facilitation

MT-BC	Demographics	Full-time Clinical Experience	Number of Sessions Facilitated at Each Site
#1	Age = 30s Race = Wh	6 years	Site 1 = 6 Site 2 = 1 Site 3 = 3
#2	Age = 40s Race = Wh	17 years	Site 1 = 0 Site 2 = 3 Site 3 = 3
#3	Age = 30s Race = Wh	11 years	Site 1 = 0 Site 2 = 2 Site 3 = 0

seated at their assigned tables or in an adjacent living area at least 30 minutes prior to the meal. When the meal was ready, those not in the dining room were escorted in by staff.

Singing Engagement

Intervention data were collected on Tuesday, Wednesday, and Thursday of Week 2 and Week 4. During treatment weeks, at least 30 minutes prior to the midday meal, participants were escorted by staff or independently arrived at the intervention environment. At Sites 1 and 2, participants were arranged at their dining tables prior to singing, whereas at Site 3, participants were clustered in the living room space adjacent to the dining room in a half circle formation. Once all participants were settled, a facilitating MT-BC began a singing session that typically lasted 30 minutes. If dietary staff indicated that meals would be delayed, the facilitating MT-BC was prepared to extend the music engagement so that no more than 10–15 minutes elapsed between the end of the intervention and the start of the meal. This seemed a reasonable procedure in accordance with findings of Götell et al. (2009) and Lesta and Petocz (2006), who advance that time spans beyond 20 minutes tend to negate any "carry-over" effects of a stimulus–response relationship for older adults with dementia. Across all three sites, the longest lapse was approximately 10–12 minutes.

Music Therapists: The PI approached three board-certified music therapists who agreed and were paid to facilitate the singing sessions. All three MT-BCs possessed experience with older adults with ADRD, musical skills more than adequate for the demands of singing facilitation, and were aware of the aims of the study. Their assignments to particular sites was based on their availability during the summer months when the study took place. MT-BC characteristics and number and location of sessions facilitated by each appear in Table 3.

Songs: Approximately 12 songs were facilitated during each singing session, most from the period of the 1940s to the mid 1960s with English language lyrics. From a treatment philosophy standpoint, the songs themselves were not seen as discrete mechanisms of influence but rather as the medium through which MT-BCs and participants interacted. In other words, the premise of the study was not that a particular song or batch of songs would affect the participants' nutritional intake directly, but rather that the intermusical, intramusical, and interpersonal features of the MT-BC facilitated singing sessions would provide opportunities for change in the dependent variable.

The key aspect of importance for song selection was the concept of familiarity, application of which can decrease problematic social behavior and negative moods states, evoke positive feelings, and strengthen older adults' sense of self (Clair, 2000; Clair & Memmott, 2008; Dassa & Amir, 2014; Douglas & Lawrence, 2015; Lesta, 2006; and Son et al., 2002). Son and colleagues (2002) explained that familiar music serves as a

stimulator of *implicit memory,* which they theorize is preserved in persons with ADRD whereas explicit memory is impaired. "Explicit memory is conscious, directed effort to recollect prior experience and facts. Implicit memory is the demonstration of the effects of prior experience without conscious recollection of that experience" (p. 264). Implicit memory is associated with learned actions and skills, including those for feeding one's self, and does not require focused conscious thought to enact but rather is automatic. The authors further hypothesize that successful enacting of learned, functional actions stimulated by familiar stimuli, such as song material, results in reinforced sense of confidence and therefore feelings of calmness and control in environments that may otherwise feel foreign and unsafe (p. 266). Implicit memory relative to engagement with familiar song material might include foot or hand tapping or clapping to a beat, humming a familiar melody, or singing or mouthing lyrics.

With the concept of song familiarity as fundamental for maximum singing engagement, the PI created an initial song list intended for potential use across all sites by adapting the procedures described by McHugh, et al. (2012). Once the initial list was created, the PI conferred with the MT-BCs and made changes on the basis of song suggestions that they provided. The PI explicitly empowered the MT-BCs to spontaneously draw from their own *practice wisdom* (Scott, 1990, p. 564) and personal repertoires of relevant song material during the sessions. This was viewed as a way to elicit, maintain, and deepen participants' engagement and interactions within the singing experience and reflects the nature of typical practice with residents with ADRD. A complete list of song material used during the sessions appears in the Appendix.

It was neither essential nor possible that the song material be performed precisely the same way per session or per therapist; however, the PI believed it important that the stylistic accuracy be preserved from session to session in order to promote participants' recognition of and sense of familiarity with the songs and the manner in which the participants would have heard them in their younger years. To that end, the PI rehearsed stylistic features with each MT-BC individually prior to treatment sessions.

Musical Facilitation: As indicated above, study participants were arranged uniquely at each of the sites during singing, with some sitting around tables and some sitting in an open living area. In a few cases at Site 1 early in the study, the MT-BC led singing while standing at an electronic keyboard on an immobile stand, but because participants were seated around a long table (some with their backs to the MT-BC), this set-up was abandoned in favor of exclusively using a strummed steel-string acoustic guitar with a strap. This allowed the guitar's sound to be strongly projected as needed and for the MT-BC to move about the room toward deepening participant engagement through physical proximity and periodic touch. This change to the facilitation protocol was carried over into Sites 2 and 3. The MT-BC applied additional techniques of engagement typically used by music therapists who work with older adults with dementias, such as the following: inserting participants' names into song lyrics; kneeling in front of a participant to elicit and maximize eye contact; exaggerating affect; judiciously using strong musical volume; altering tempo; using fermatas in strategic places within a song, briefly improvising vocally in response to a resident's musical offerings, and shortening or extending a song by returning to a particular verse or refrain more than once (Cevasco, 2010; McHugh et al., 2012; Young, 2013). As additional points of interest relative to the music, the MT-BC occasionally spoke briefly about a song's composer, the performer who recorded or made the song famous, or the historical context of the song (e.g., Depression Era, WWII, popular musical). This sort of verbal introduction sometimes led to residents offering their own ideas, memories, or associations relative to the song material. These responses were encouraged when they occurred, just as they would be in actual clinical situations. Verbal interactions with this clientele were typically rather brief due to the cognitive limitations associated with dementia.

Post-Singing Data Collection

Research Assistants

Two undergraduate music therapy students volunteered and were paid to act as research assistants for data collection. The students were oriented to the study and trained in the use of the digital kitchen scale that would be employed. The research assistants accompanied the PI to Site 1 for a "dry run" in order to practice weighing food trays and recording data and to identify and correct any errors in the data collection procedures. During actual sessions, the assistants weighed the trays, plates and bowls of food, and drinking vessels, recorded the data, and monitored participant responses during the meal for confounding events (see below).

Data Collection Procedures

Because of differences in site dining protocols, post-singing data collection was handled similarly at Sites 1 and 2 but differently at Site 3 as follows.

Sites 1 and 2: Participants' meals were delivered no more than 10 minutes after the conclusion of the singing session. Each resident's meal arrived on an individual tray, complete with entrées and side dishes with large and small plastic covers, cups, flatware, and a napkin. One research assistant removed the large entrée cover and weighed each tray on a digital kitchen scale: Accuweight Digital Kitchen Scale - Electronic Meat/Food Weight Scale, 5 kg/11 lb. The assistant then verbally reported the weight in grams to the second research assistant, who recorded the number on a form prepared specifically for this purpose. The tray was then served to the resident by the PI, a research assistant, or site staff. Residents were monitored while eating by the PI and research assistants for any confounding events, such as residents sharing food with one another, residents taking food from another's tray, dropped utensils, and requests for additional food or beverage, which was then independently weighed and added to that individual's initial grams. Residents were determined to have finished their meals when they got up of their own accord and left the table or the room. In many cases, residents verbally indicated that they were done eating. Sometimes they simply ceased eating or pushed their tray away but remained at the table; when this occurred, the residents were asked to confirm that they were indeed finished before their tray was removed. In general, most residents completed their meals within 30 minutes. Prior to weighing each tray a second time, all efforts were made to restore the tray to its original state, minus the food and drink that had been consumed, so, for instance, dropped silverware and small plastic lids were replaced. The second weighing occurred as the first, the entrée cover was replaced, and the tray returned to the tray cart.

Site 3: At the conclusion of the singing session in the living room area, staff escorted the residents to their pre-assigned seats in the dining room. Unlike Sites 1 and 2, resident's meals were not served from a tray. Silverware and a napkin were arranged when they arrived at their tables. At each seat were also a cup of water and a cup of juice, each of a consistent volume pre-determined by dietary staff and pre-weighed by the research assistants. The dining area at this site had a kitchenette where all individual plates were prepared. In general, residents were offered an entrée, a salad or fruit cup, a bowl of soup, and a dessert at each meal. Kitchen staff prepared two different entrée plates for each resident, displayed and described each plate to each resident, and residents selected their choice of entrée. The research assistants weighed each entrée plate once, then recorded grams for each resident's selected entrée only. The same half-cup ladle was used to measure all soup and fruit cups. An initial measurement of each was taken and applied to all residents' data. Likewise, the dessert that was offered later in the meal was presumed to have been of consistent weight and thus a model was weighed and this weight generalized to all residents' data.

As at Sites 1 and 2, the PI and research assistants monitored activity during the meal in the Site 3 dining area, noting any potentially confounding incidents and variables and discerning when residents had finished eating and their dishes were ready to be

Table 4
Difference in average food intake by location and condition

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Location	2	144791.85	72395.92	2.56	0.08
Type	1	34806.44	34806.44	1.23	0.27
Location*Type	2	70011.14	35005.57	1.24	0.29

Table 5
Difference in average intake between location pairs for baseline and treatment days.

Location	Ave Grams LSMEAN	LSMEAN Number
Site 3	488.87	1
Site 1	438.00	2
Site 2	399.63	3

reweighed. The research assistants used a pre-weighed tray to collect each resident's dishes, weighed the tray with these items, and then subtracted the weight of the tray to arrive at the post-meal weight.

Results

Two factors considered in the data analysis were location of the intervention (Site 1, Site 2, Site 3) and condition (baseline condition with usual care and treatment condition with singing). The response variable was the weight of average food intake in grams. The data used were the average grams consumed by residents per week, categorized by location and condition. An ANOVA was used to determine differences in average food intake for the three sites and for baseline and treatment conditions. Differences in average intake between pairs of sites were explored using Tukey's method while t-tests were conducted to examine differences in food intake within each site for baseline and treatment conditions.

The ANOVA yielded no significant results at the 0.05 significance level for average food intake by location, nor by condition.

Tukey's method was employed to investigate differences in the average intake between pairs of locations. In this comparison, averages were taken over all baseline and treatment days. Comparisons of mean intake between Site 1 and Site 2 (0.37), Site 2 and Site 3 (0.60), and Site 1 and Site 3 (0.06) were each insignificant at 0.05 p value, however, the difference between Site 1 and Site 3 borders on significance and is worthy of closer inspection.

To investigate potential differences in average food consumption within each location depending on condition, t-tests between the baseline scores and the treatment scores were carried out with insignificant results for all three sites. However, an observation deserving careful consideration is that, contrary to the projected hypothesis, the mean intake at both Site 1 and Site 3 was actually *greater* for baseline days than for treatment days.

Discussion

Comparison of the average volume of food intake between baseline and treatment conditions revealed no significant differences for all participants; thus, the hypothesis that intake would increase with the music intervention was rejected. Most surprising was the finding that participants at Sites 1 and 3 actually consumed slightly more during baseline than treatment days. Although contrary to the researcher's prediction, this finding is similar to one reported by McHugh and colleagues (2012); they noted that

Table 6
Difference in average intake within locations per type of session

Site 1:		
	Baseline	**Treatment**
Mean	478.56	397.44
Variance	25642.07	43346.11
Observations	20	20
Hypothesized Mean Difference	0	
df	36	
t Stat	1.38	
P(T<=t) two-tail	0.17	
t Critical two-tail	2.02	
Site 2:		
	Baseline	**Treatment**
Mean	380.91	418.35
Variance	22597.99	12683.41
Observations	16	16
Hypothesized Mean Difference	0	
df	28	
t Stat	-0.79	
P(T<=t) two-tail	0.43	
t Critical two-tail	2.04	
Site 3:		
	Baseline	**Treatment**
Mean	520.20	457.53
Variance	31975.65	29224.38
Observations	20	20
Hypothesized Mean Difference	0	
df	38	
t Stat	1.13	
P(T<=t) two-tail	0.26	
t Critical two-tail	2.024	

control waitlist participants who were not engaged in group singing ate more food on average as compared to their peers who received the intervention.

In response to these results, important questions arise: Why did average food intake increase slightly during the no-music, or baseline, condition? Furthermore, why did the increase occur at two sites but not the third?

People take in food for many different reasons, one of which is appetite, or the desire to eat. We know that appetite is mediated by multiple environmental and intrapersonal factors, and that these "Factors affecting nutrition and hydration in people living with dementia are complex and inter-related" (Nell et al., 2016, p. E1). A discussion of certain relevant factors related to appetite follows in an attempt to uncover plausible answers to the aforementioned questions.

Environmental Factors

Much of the literature related to food intake of people with ADRD consistently advocates for a calm dining environment (Douglas & Lawrence, 2015; Prince et al., 2014; Suma et al., 2018; Volkert et al., 2018). In that auditory overstimulation and distractions were apparent during meals at all three sites (e.g., residents calling out in the dining area; loud conversations between staff, residents, and visitors; music "bleeding" in from adjacent rooms), it is possible that study participants experienced anxiety and confusion that contributed to changes in appetite and commensurate decreases in intake. That said, one might confidently dismiss this factor as related to study findings in that these sounds were not unique to either the treatment or baseline conditions; rather, the dining experience at all three sites was consistently characterized by stimuli of these types, frequencies, and intensities.

Intrapersonal Factors

Certain intrapersonal attributes may cause variations in appetite and thus should be examined for potential explanatory power. These include the participants' diagnostic profiles, food preferences, and physical states.

Diagnostic Profiles

All study participants carried a diagnosis of dementia; the specific type for each individual was not known to the PI. It is presumed that some participants had probable Alzheimer's type, while others may have had Parkinson's, Lewey bodies, vascular, or frontotemporal types. In contrast to a decrease in appetite characteristic of most forms of dementia, increased appetite among those with frontotemporal dementia is common and is, in fact, a diagnostic criterion for this dementia variant (Ahmed et al., 2014; Ikeda et al., 2002; Mendez et al., 2008). Individuals with frontotemporal dementia often exhibit increased appetite, alterations in food preferences, cravings for carbohydrates and sweet foods, certain food obsessions, and weight gain (McKieth & Cummings, 2005; Mendez et al., 2008). Unknown to the PI, there may have been individuals with frontotemporal dementia among the participants. However, increased consumption likely would be consistently manifested during meals, and fluctuations across baseline and treatment conditions thus would not be anticipated.

Personal Preferences

Personal food preferences and perceptions of food quality (i.e., appearance, taste, smell, temperature, and texture) also might be implicated in a change in appetite, leading to decreased intake (Nell et al., 2016). Yet, in that food options and fluctuations in meal quality were most likely relatively stable over time—that is, presuming consistency in dietetics and food preparation staff and food products at the sites—, it could be assumed that the influence of personal preferences among participants "averaged out" over baseline and treatment conditions.

Physical States

Appetite varies based, in part, on one's current physical condition (Prince et al., 2014). The impact of medication, disease, temporary illness, and so forth is difficult to discern, but one could assume that those participants who did not feel well enough to participate in the singing sessions or the mid-day meal (for whatever reason) would have self-selected out of the treatment session. In fact, this happened on rare occasions. It is also possible, however, that a participant might have felt well enough to attend the singing session but felt worse over time, such that they ate less than usual when their meal was served. No participants verbalized feeling ill just prior to or during the meal, but this does not mean that this situation did not occur. Even if it had, however, an

isolated case or handful of cases over the duration of the study would likely not have had a meaningful impact on average consumption data.

Music, Reward, and Neurobiology

Pleasurable experiences have been shown to lead to the release of certain neurotransmitters including serotonin, which is produced in the nucleus accumbens (NAc) and hypothalamic regions of the brain (Chanda & Levitin, 2013; Mavridis, 2015; Menon & Levitin, 2005; Taylor, 1997). In fact, Mavridis referred to the nucleus accumbens as, "the most important pleasure center of the human brain (dominates the reward system)…" (2015, p. 121), and reported that "…reward value for music can be coded by activity levels in the NAc, whose functional connectivity with auditory and frontal areas increases as a function of increasing musical reward" (p. 121). Thus, engaging in inter-musical and inter-personal processes inherent in group singing with an MT-BC can be viewed as emotionally and socially rewarding on a neurological level (Altenmüller & Schlaug, 2013; Chanda & Levitin, 2013; Evers & Suhr, 2000; Mavridis, 2015). Altenmüller and Schlaug (2013) write,

> … listening to music and making music provokes motions and emotions, increases between-subject communications and interactions, and—mediated via neurohormones such as serotonin and dopamine—is experienced as a joyous and rewarding activity through activity changes in amygdala, ventral striatum, and other components of the limbic system (p. 11).

In studying the "neural mechanisms underlying intensely pleasurable emotional responses to music," Blood and Zatorre (2001) asked university students to listen to preferred and nonpreferred recorded musical selections (p. 11818). Positron emission tomography (PET) scans of brain activity revealed that pleasurable experiences of music were correlated with increased activity in the nucleus accumbens. Although these researchers did not specifically measure the presence and volume of serotonin, one might conjecture that increased activity in the nucleus accumbens may have triggered such production, as highlighted by Altenmüller and Schlaug (2013). In fact, Blood and Zatorre note that activity in the region of the nucleus accumbens is directly related to processes of neural reward and is "known to involve dopamine and opioid systems, as well as other neurotransmitters" (p. 11822).

In what seems to be a rigorously designed and executed trial, Evers and Suhr (2000) found a significant correlation between healthy adult participants' perceptions of music listening experiences as either "pleasant" or "unpleasant," and report an increase of blood platelet serotonin levels for both, with pleasant music yielding significantly higher levels compared to unpleasant music. Menon and Levitin (2005) used functional magnetic resonance imaging (fMRI) to examine connectivity between various brain structures involved in neurologic reward to music listening in adult non-musicians: the nucleus accumbens (NAc), the ventral tegmental area (VTA), and the hypothalamus. Participants listened to a random series of classical music segments in typical and "scrambled" forms in 24-second episodes. Results for the segments considered pleasant versus not pleasant (i.e., scrambled) showed significant activation of the structures in question with significant neural connectivity between them and with indication of a recognizable pattern of activation. As in the Blood and Zatorre (2001) study, Menon and Levitin did not measure the presence and volume of serotonin, yet it is plausible that release of serotonin would, in fact, occur due to stimulation of the NAc related to the experience of a pleasant, rewarding musical stimulus.

The relationship between musical engagement as a rewarding activity with concurrent serotonin production is relevant to the present discussion primarily because the function of serotonin as an appetite suppressant is well-documented in the scientific literature (Blundell & Halford, 1998; Wurtman & Wurtman, 1995, 2018). Liebowitz and Alexander (1998) reviewed research on the impact of hypothalamic serotonin on appetite. The authors explain that stimulation of serotonin receptors of the hypothala-

mus "…reduce food intake and weight gain and increase energy expenditure, both in animals and in humans" (p. 851). These authors also argue that pre-meal consumption of carbohydrates "…enhances the synthesis and release of hypothalamic 5-HT [serotonin], which in turn serves to control the size of carbohydrate-rich meals" (p. 851). Wurtman and Wurtman (1995, 2018) concur with the relationship between carbohydrates and serotonin release and support the notion that, regardless of the manner in which serotonin is produced, it is influential in regulating appetite and eating behavior.

It seems that as far back as 1998, the scientific evidence for the impact of serotonin as an appetite suppressant was considered conclusive. Blundell and Halford's (1998) review of 20 years of research on drugs designed to suppress appetite by either stimulating serotonin production or inhibiting serotonin reuptake reported unequivocally that, "A consistent pattern of reduction in hunger motivation and energy intake is seen in human studies with a variety of serotonergic agents" (p. 474). In fact, it is difficult to find current research designed to reinforce or refute this now established relationship, and researchers have moved on to focus on clinical applications of serotonin's role in health concerns such as depression, suicidality, and obesity (Wurtman & Wurtman, 2018).

In that music engagement stimulates serotonin production and serotonin suppresses appetite, it is possible that study participants at sites 1 and 3 experienced these effects—that is, adequate stimulation of serotonin by engaging in pleasurable music experiences resulted in diminished appetite during the subsequent meal, thereby explaining the lower average food intake during treatment weeks.

Inconsistencies

Unlike participants at Sites 1 and 3, mean food intake on singing days for participants at Site 2 was greater than baseline days, indicating potentially less serotonin release for these individuals. Two interrelated explanatory factors are most relevant: the environment and the MT-BCs who provided singing engagement. First, compared to the treatment environments at Sites 1 and 3 (and as noted in Table 2 above), the dining tables at which Site 2 participants sat were widely dispersed in the multi-purpose room. The MT-BCs reported that this made it difficult to effectively use close proximity as a technique for enhancing engagement and promoting relationship. Secondly, Site 2 was the only location wherein three different MT-BCs provided singing engagement during treatment days. This unavoidable variation in facilitators may also have adversely affected the potential for therapeutic relationship to develop between the participants and facilitators, even on the very basic level of participants experiencing familiarity with the MT-BCs' physical appearance. It may be the case, therefore, that the musical experiences for Site 2 participants on treatment days were insufficient for stimulating serotonin production with commensurate limited change in food intake status versus baseline days.

Lastly, results showed that participants at Site 3 consumed, on average, more grams of food and beverage than those at Site 1; the difference amounted to approximately 89 grams. Differences in the environment and meal processes between Sites 1 and 3 might account for Site 3 participants' more productive eating. For example, from the PI's perspective, the environment of Site 1 was considerably more stimulating than Site 3 in terms of the sheer volume and variety of sounds from various sources as well as a higher level of physical activity occurring in and around the dining space by non-participant residents and staff. This was largely due to the fact that participants at Site 1 were not isolated in their own memory support unit, as were the Site 3 participants, but rather lived on a floor of the facility among many other residents who shared the space. With regard to meal processes, residents at Site 3 were consistently offered a choice of entrée, carried out by staff presenting two different plates of food for the participants to see, ask questions about, and thereby choose their meal. Thus, it might simply be the case that having a choice in the dining moment based on seeing and,

perhaps, smelling the food stimulated appetite, more productive eating, and therefore greater average intake.

Limitations and Recommendations

Given the varied environments encountered and the fairly small sample size in this study, generalization of the findings must be considered carefully. Whereas great care was exercised with regard to song choices and stylistic preparation, differences between the appearance, vocal timbre, and interpersonal approaches of the three music therapists may have differentially impacted the way the residents perceived and engaged in the singing process, and therefore their later behavior during mealtime. Consistency of a single therapist, with the related potential for developing and sustaining stronger relationships with the residents, may induce different results.

Assuming the potential adverse relationship between enjoyable music engagement that stimulates serotonin production and the proven appetite suppression characteristics of serotonin, it seems prudent to recommend, although cautiously, that care be exercised regarding the timing of active music engagement and mealtimes for persons with dementia whose health status may include nutritional complications. How long it takes for the serotonin production and metabolism that may occur due to enjoyable music engagement is unknown. In fact, questions regarding typical processing of serotonin remain as they are multifaceted and require complex mathematical formulas that are still under investigation and development (Best et al., 2010). Given that serotonergic processes are constantly occurring in the brain, and without evidence to the contrary, 30 to 60 minutes between active music engagement and the start of a meal seems a reasonable recommendation. Whereas this recommendation may appear problematic or inconvenient for music therapists, it is nonetheless important to consider that music has both the potential for promoting health and well-being, but also to cause harm or detrimental effects (Gardstrom, 2008; Hiller & Gardstrom, 2019). Careful attention to scheduling of music therapy sessions for individuals with dementia and nutritional challenges may ameliorate concerns in this regard.

The intent of the present study was to discern whether or not singing would stimulate food intake. It must be noted, however, that participants' musical involvement varied: Not all participants vocalized, in spite of the MT-BC's consistent use of techniques of engagement that have been documented in the literature as useful and effective in the treatment of older adults with dementia (e.g., use of participants' names, proximity, and alterations to musical elements and form; Cevasco, 2010; McHugh et al., 2012; Young, 2013). While certain individuals in the groups were prone to fairly consistent singing or inaudible mouthing of the words in "real time," others sang or mouthed words only sporadically during the sessions. On average, across all sites, approximately one third of participants fit into these two categories. The balance of participants engaged more as listeners—watching the MT-BC as she moved about the space, tapping their feet or hands, and smiling in response to certain songs and verbal comments. The implication of these observations is that findings might be interpreted as applying not only to the experience of active engagement through singing but also to the experience of active engagement through listening. Researchers might consider tracking individual participants' level of engagement during music-based treatment episodes through videotape or observations of trained observers; this could identify relationships between an individual's level of musical engagement and subsequent manifestations of symptomology or healthy sorts of responses. Future researchers may also wish to address the concept of engagement—what it feels like for a participant and what it looks like for an observer—and factors that may be involved at different levels of engagement. Interpretivist (i.e., qualitative) research may bring light to the feeling-full and motivational nature of singing engagement for both residents and therapists as well as ground theorizing in the phenomenon of singing engagement with others. Lastly, future researchers might benefit from tracking the specific dementia diagnoses of par-

ticipants, as differential symptomology surrounding the various types have a bearing on dietary needs and eating habits.

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