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The Effect of Instrumental and Vocal Music on Adherence to a Physical Rehabilitation Exercise Program with Persons who are Elderly

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This study compared live, instrumental music, vocal music, and no music on the repetition frequencies for 14 prescribed physical therapy rehabilitation exercises. Male (N = 4) and female (N = 15) residents of care centers for older adults served as subjects. They ranged in age from 65 to 90 years (M = 84.3), and were either referred to physical therapy or were already involved in a physical therapy exercise program. All subjects (N = 19) participated in 6 treatment sessions under 3 conditions: Two sessions with live instrumental music, two with live vocal music, and two with no music. In all music sessions, familiar and recognizable songs were paired with specific exercises. Each exercise in all conditions had the same duration, and a metronome established consistent tempos. Each session was videotaped for later review and data collection. Analyses of variance were calculated for treatment effects and mean differences among the three conditions which yielded significant treatment effects and treatment differences among conditions for 6 of the 14 exercises. Unsolicited comments from subjects indicated preference for music over no music conditions while exercising. Further study is required to establish the relationship between music

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enhanced exercises and adherence to exercise regimens in populations of older adults.

The elderly population of the United States continues to show a rapid growth rate due to advances in health care, pharmaceutical treatment, and technology. According to the Administration on Aging (1998), people aged 65 and over are projected to represent 20% of the population or 70 million by the year 2030. As the number of older persons increases, so does the need for services that address their physical, social-emotional, and intellectual needs and interests (Christie, 1992), including activities for daily living (ADLs) and instrumental activities of daily living (IADLs).

Deficits in ADLs, including bathing, dressing, eating, and mobility at home and IADLs, such as meal preparation, shopping, using the telephone, housework, and taking medication reflect, in part, physiological changes that increase medical and subsequent social and emotional problems for elderly persons. These changes affect directly physical function and life quality (Winograd, 1995a) and physical rehabilitation is required to restore physical function and to prevent further decline (Winograd, 1995b). Inactivity, bed rest, and a lack of exercise physically compromise an elderly individual's health and well being. Research shows such inactivity has many harmful physical and psychological effects on the body's systems (Corcoran, 1991; Harper & Lyles, 1988). In fact, the most deleterious effect of aging which often leads to institutionalization is inactivity (Kartman, 1980).

Research indicates the benefits of exercise for older people which include (a) minimized coronary heart disease with improved cardiovascular fitness, strength and flexibility; (b) decreased body fat with increased lean body weight; (c) increased flexibility of joint structures, which protects against osteoporosis (Simpson, 1986); (d) increased mental achievement or learning potential; (e) improved socialization and self-concept; (f) increased relaxation; and (g) improved morale and positive affect (Biegel, 1984; LaRocque & Campagna, 1983). LaRocque and Campagna (1983) reported that exercise programs facilitate positive expressions and enjoyment for elderly persons in residential care while Monicken (1991) stressed exercise as an essential component to life quality, even in physically frail older adults. Harada, Chiu, Fowler, Lee, and Reuben (1995)

found that balance and overall functional performance improved in older persons with exercise. They suggested that prescribed physical exercise interventions may prevent, minimize, or even reverse functional decline, and possibly prevent further residential care. These potential outcomes have huge implications for decreased care costs for older, frail persons.

Positive results associated with rehabilitation exercise, require adherence to the program which can be a problem (Dishman, 1982). Adherence occurs when people are motivated to participate due to positive experiences that maintain their interest and suit their comfort levels.

Music adds interest and positive experiences to exercise regimens and improves participation for older persons. LaRocque and Campagna (1983) found that a physical exercise program with music helped older persons discover pleasure in movement. O'Konski (1996) also found that elderly persons demonstrated significantly better adherence to exercises with music than without it. Given these outcomes, it is possible that music can motivate exercise participation, and can concomitantly facilitate exercise adherence.

While music affects exercise outcomes, a requisite component is appropriate music selections that serve to complement the exercise movements (Thaut, 1999). Therefore, consideration of tempo must closely match the pace with which persons perform the exercise movements (Clair, 1996; Thaut, 1999; Wade, 1987); and the music must be at loudness levels that allow sensory perception and appropriate comfort levels (Clair, 1996).

When physical movements occur within the music context, they are influenced by rhythm which serves as an external timekeeper to organize and entrain motor responses (Thaut, 1999). This rhythmic auditory stimulation (RAS) relies on the physiological effects of auditory rhythm on the motor system to improve the control of movement and facilitate rehabilitation of movements that are intrinsically biologically rhythmical (Thaut, 1999).

The response of rhythmic auditory stimulation (RAS) is the topic of extensive research. Results have shown significant cognitive and physiological influences of rhythm on motor control and functioning primarily with ambulation in normal individuals (Prassas & Thaut, 1992; Thaut & McIntosh, 1992; Thaut, McIntosh, Rice, & Prassas 1992), in stroke rehabilitation (Thaut, McIntosh, Prassas, & Rice, 1992; Thaut, McIntosh, Rice, & Miller, 1995; Thaut,

McIntosh, and Rice, 1997; Thaut, McIntosh, Rice, & Prassas, 1993), for maintenance of function in Parkinson's disease (McIntosh et al., 1995; McIntosh, Brown, Rice, & Thaut, 1997; Thaut et al., 1996), and rehabilitation for patients with traumatic brain injury (Hurt, Rice, McIntosh, & Thaut, 1998). As a result of this research, the scientific model for rhythmic auditory stimulation (RAS) is well established.

While rhythmic auditory stimulation has such a profound influence in studies of ambulation, it is also possible for it to have positive effects on other physical movements, which comprise a therapeutic, rehabilitative exercise program. There is a need to examine the effects of external rhythm on physical functioning to determine functional outcomes that prove beneficial in physical rehabilitation programs, including those designed to build and maintain strength in older adults.

Thaut, Kenyon, Schauer, and McIntosh (1999) envision applications of auditory rhythms for specific therapeutic purposes in the rehabilitation of persons with a wide array of movement disorders. It is possible that music can enhance therapeutic exercise outcomes to maintain, or even increase, physical function through providing rhythmic entrainment, motivation, and decreased perceptions of discomfort; and, therefore contributing to better adherence to exercise regimens.

These physical regimens are essential for older persons to maintain their health and well-being, and to prevent, or slow, functional decline due to aging. While research has shown the benefits of exercise to maintain function in older persons, the likelihood for dropout is high. Therefore, there is a need for programming that facilitates adherence. Research also suggests that incorporating music with a physical rehabilitation exercise program can enhance the experience and improve the overall engagement of the participants as it lessens the perceptions of difficulty, monotony, and discomforts associated with the exercise (MacNay, 1994).

The purpose of this study was to investigate the effectiveness of instrumental and vocal music on adherence, as indicated by numbers of repetitions, to an exercise regimen. This study was designed to answer the following: Is adherence, as indicated by repetition frequency, to prescribed physical therapy exercises affected by music? More specifically, does the frequency of physical therapy exercise repetitions vary according to the conditions under which they

are performed a) instrumental music, b) vocal music, and c) no music control?

Method

Subjects

Fifteen female and four male residents ($N = 19$) with physical frailties from two community living centers and one residential retirement center volunteered to serve as subjects. They ranged in age from 65 to 90 years with a mean age of 84.3 years. Presenting problems included muscle rigidity, limited range of motion, deficits in physical endurance, compromised mobility, restricted flexibility, poor muscle tone, and slow, unstable ambulation. All subjects were either referred to receive physical therapy or were already involved in a physical therapy exercise program at their respective facilities.

Physical Therapy Exercise Protocol

Fourteen exercises comprised the 20-minute protocol designed for physical therapy rehabilitation for older persons. The sequence, content, and number of exercise repetitions in the protocol were approved by physical therapy specialists in gerontology at a Veterans Affairs Medical Center in the Midwest. To assure appropriate and desired functional, physical outcomes, the protocol included movements of shoulders, hands, arms, head, neck, legs, ankles and feet. Figure 1 lists the exercises, repetition frequencies, and the respective musical selections with meter and time signature indications.

Procedure

A pilot study was conducted to test the feasibility of the experimental procedure with five subjects from a Midwestern Veterans Affairs Medical Center. Results indicated that the procedure was practical and appropriate. The pilot subjects' data were not included in the research analysis.

The 19 subjects in the experimental study served as their own controls as they participated in a series of six sessions in which a 20-minute protocol for physical rehabilitation exercise was performed under three, randomly ordered conditions: Instrumental music ($n = 2$), vocal music ($n = 2$), and no music ($n = 2$). Subjects participated in groups of five in their respective facilities, in the same room, at the same time of day, two to three times weekly until all

Exercise	Song	Meter	Metronome	Repetitions
Shoulder rolls	Take Me Out to the Ballgame	Three quarter time	132	16
Handflex & Supinate/pronate	Don't Sit Under the Apple Tree	Cut time	84	32
Toe taps & heel lifts	Crawdad Song	Cut time	88	64
Head rotation & ear to shoulder	Swing Low, Sweet Chariot	Four quarter time	96	16
Knee extension	In the Good Old Summertime	Three quarter time	126	16
Rowing	Row, Row, Row Your Boat	Two quarter time	80	8
Knees together & apart	Hey, Hey Good Lookin'	Four quarter time	116	32
Marching	Saints Go Marching In	Cut time	92	32
Bicep curls	Your Cheatin' Heart	Four quarter time	112	32
Bucket lifts	Let Me Call You Sweetheart	Three quarter time	108	16
Arms across chest	Daisy, Daisy	Three quarter time	120	32
Adduction/ abduction & Internal/external rotation	Blueberry Hill	Four quarter time	104	16
Ankle circles	Hello My Baby	Cut time	120	32
Arm extensions	Down in the Valley	Three quarter time	112	12

FIGURE 1.
Exercises, songs, meter signatures, metronome readings, and exercise repetitions.

sessions were complete. All sessions were videotaped with a camera on a tripod for later data collection.

As subjects arrived at each exercise session, they were greeted individually by the investigators. For all sessions, the subjects were seated side by side in straight-backed chairs which allowed them to see the investigator/facilitator in front of them, and allowed inclusion in the video camera viewing field. One of the investigators, trained by a physical therapist, facilitated engagement by introducing verbally and modeling physically each exercise at the appropri-

ate tempo. To assure consistency in the protocol delivery, an auditory tape was used to cue the investigator who facilitated the exercises. The auditory tape announced each exercise followed by 5 seconds of metronome beats at the tempo determined for the particular exercise. During the five seconds of auditory beats the experimenter matched the tempo as he demonstrated the exercise movement. Upon the conclusion of the 5-second beat interval, the tape gave a verbal directive for the subjects to "begin" the exercise. The experimenter continued the physical demonstration of the movement throughout the duration of each exercise. At its conclusion, an auditory cue directed subjects to "stop". A 5-second interval of silence followed. This procedure was repeated for each of the 14 exercises in the protocol. See Figure 2 for an outline of the procedure for individual exercises within the protocol.

No verbal prompts or physical gestures were used to further encourage participation at any time during the protocol. At the conclusion of each session, the investigators thanked all subjects individually and reminded them of the next scheduled session. At the conclusion of all sessions, the investigators thanked all participants for their contributions to the study.

The protocol sessions were run three to five times weekly over a period of 8 weeks at each facility to accommodate make-ups for missed sessions due to illness or medical appointments. When subjects completed their respective series of six experimental sessions, they were encouraged to continue in the group, but data were not taken for their subsequent sessions. All subjects completed their experimental series within the 8-week period the sessions were run at their respective facilities.

For the protocol, three conditions were ordered randomly to include one condition per session, two sessions per condition, for a total of six experimental sessions. These conditions included (a) live trombone instrumental music, (b) live vocal music, and (c) no music. The trombone was selected because it was one investigator's major instrument, was comfortable to play, and was accessible. It was also acceptable because it is a melodic instrument with a loudness level that is easily adjusted.

For both the trombone and vocal music, 14 songs in country, pop, and spiritual styles were selected for their familiarity to the subjects. Figure 1 lists the titles of all the songs used. Each song was paired with a specific exercise in the protocol according to com-

1. Auditory Cue: Verbally Presented Exercise Title
2. Auditory Cue: Five-Seconds of Metronome Beats with Physical Demonstration of Modeled Exercise Matched to the Beat
3. Auditory Cue: "Begin"
4. Continued Physical Demonstration Model of Exercise Provided by Facilitator
5. Auditory Cue: "Stop"
6. Five Seconds of Silence

FIGURE 2.
Procedure summary for individual exercise implementation.

patibility of movement with the meter, rhythm, and tempo of the song. Each song was also performed at a specific metronome reading which permitted participation at a comfortable pace. All songs were unaccompanied whether they were sung (vocal condition) or played on the trombone (instrumental condition).

At the conclusion of the exercise regimen, subjects were encouraged to choose to either sing a song with the experimentors, or to hear a song played on the trombone. This provided closure to each session and data were not collected at the closing.

Data Collection and Analysis

Each session was videotaped for later review and data collection. An observer was trained to record the frequencies of repetitions of each subject for each exercise in all conditions.

To determine test-retest reliability after training, the observer was required to evaluate and then reevaluate one videotape following a period of 2 weeks. Reliability was calculated by subtracting the number of disagreements from the number of agreements divided by the total number possible for the two data collection observations. A reliability coefficient of .97 was derived that exceeded the *a priori* criterion level of .90.

After the observer had collected all frequencies of repetitions for each subject in each exercise for all sessions, analysis of variance was used to test for any significant treatment effects and mean differences among the three conditions per exercise. A randomized complete block design was used for three conditions by 19 subjects/blocks by two repetitions.

Results

Treatment effects and mean differences among conditions were not statistically significant for Exercises 1, 3, 4, 7, 9, 12, 13, and 14.

Statistically significant differences were found at $df = 2$ for Exercises 2, 5, 6, 8, 10, and 11. Calculations of analyses of variance yielded significant treatment effects for conditions in Exercise 2, hand-flex/supinate & pronate, $F = 6.146$, $p = .003$, Exercise 5, knee extensions, $F = 4.514$, $p = .014$, Exercise 6, rowing, $F = 7.119$, $p = .001$, Exercise 8, marching, $F = 3.255$, $p = .043$, Exercise 10, bucket lifts, $F = 11.424$, $p = .000$, and Exercise 11, arms across chest, $F = 3.535$, $p = .033$. Tests of differences between the means yielded statistically significant differences for these six exercises. Namely, a mean difference of 2.89 was statistically significant at $p = .004$ between instrumental music ($M = 27.26$, $SD = 5.16$) and no music ($M = 24.37$, $SD = 3.31$) for Exercise 2, hand flex/supinate & pronate. This indicated more movement repetitions in Exercise 2 during instrumental music compared to no music. A mean difference of 2.24 was statistically significant at $p = .017$ for Exercise 5, head rotation/ear to shoulder where movement repetitions were higher during no music ($M = 20.13$, $SD = 4.42$) than during vocal music ($M = 17.89$, $SD = 4.42$). For Exercise 6, rowing, the vocal music condition ($M = 9.74$, $SD = 2.11$) yielded more movement repetitions than the no music condition ($M = 8.55$, $SD = .98$) and a mean difference of 1.19 that was statistically significant at $p = .001$. For Exercise 8, marching, instrumental music ($M = 29.47$, $SD = 9.16$) showed more movement repetitions than no music ($M = 26.79$, $SD = 5.70$), and the mean difference of 2.68 was significant at $p = .043$. In exercise 10, bucket lifts, a mean difference of 2.03 was statistically significant at $p = .000$ where no music ($M = 17.32$, $SD = 2.08$) indicated more movement repetitions than instrumental music ($M = 15.29$, $SD = 2.00$). For the same exercise, no music ($M = 17.92$, $SD = 2.08$) also indicated more movement repetitions than vocal music ($M = 15.39$, $SD = 2.94$) with a mean difference of 1.92 statistically significant at $p = .000$. During Exercise 11, arms across the chest, no music ($M = 29.63$, $SD = 3.90$) resulted in more movement repetitions than vocal music ($M = 27.74$, $SD = 4.75$), and had a mean difference of 1.89 that was statistically significant at $p = .045$.

Though statistical differences in frequencies of repetitions were found among the conditions, they were not consistent. Music yielded higher repetition frequencies in Exercises 2, 6, and 8 while no music resulted in higher frequencies in Exercises 5, 10, and 11.

Analyses of variance at $df = 2$ yielded a significant treatment by time interaction for toe taps and heel lifts in Exercise 3 ($F = 3.866$,

$p = .025$) and for knees together/apart in Exercise 6 ($F = 4.395$, $p = .015$). Exercise 3 shows that the interaction is the result of a significantly higher no music condition mean score of 56.79 ($SD = 7.67$) on Session 2 compared to a mean score of 49.84 ($SD = 11.85$) on Session 1. Means scores for Exercise 6 show that the interaction is the result of a significantly lower instrumental condition mean score of 8.53 ($SD = 1.58$) on Session 2 compared to a higher mean score of 9.84 ($SD = 2.52$) on Session 1. The reasons for these interactions between Sessions 1 and 2 are unclear. These data, and observations of subjects' participations, gave no indication of how scores decreased from Session 1 to Session 2 of the same condition.

Discussion

The data for this study, designed to determine whether prescribed exercise adherence was affected by music, indicated significant treatment differences in six of the 14 exercises. Increases in repetitions occurred with music in three of these six, while repetitions decreased with music in the remaining three exercises. One explanation for such outcomes lies in the adherence measurement, the number of repetitions for each exercise. The decision to use repetition frequencies was derived from the pilot test which indicated that fewer repetitions represented less adherence to the exercise protocol. Therefore it was assumed that lower frequencies represented less engagement in participation, and was an indication of adherence. Observations during the data collection phase of the experimental study revealed nonadherence could result from faster, more frequent movements that did not comply with the movement contours and ranges of motion indicated for the appropriate execution of the exercises. These noncompliant movements were manifested by some subjects as rapid repetitions with poorly formed contours which did not adequately reflect visual models, especially in the nonmusic condition. Consequently, these high frequency repetitions did not accurately represent adherence to the exercise protocol.

In the no music condition, the absence of auditory, rhythmic pulse deprived subjects of the structure provided by auditory beats in music, though a leader demonstrated each movement throughout its prescribed duration at a tempo set by a metronome. With no music, some subjects moved quickly while others were slow and/or intermittent movers. When the music conditions were used, the in-

herent rhythm in the music seemed to function to cue pacing that encouraged fluid, full-range movements. Therefore, the movements were less frequent, but appropriate for desired functional outcomes. Observations indicated that movements performed without the music were not as fluid with a tendency for variations in frequencies depending on persons' physical functioning levels. Consequently, numbers of repetitions for the array of exercises did not adequately represent good adherence, since it was important for the subjects to move slowly in some exercises with fewer repetitions to achieve the maximum benefit. It was concluded that counting frequencies of movement repetitions was an inappropriate measure of exercise adherence.

The instrumental music condition achieved the best adherence results on Exercise 2 (hand flex) and Exercise 8 (marching). It is possible that the subjects' movements in these two exercises were enhanced by the particularly strong pulses and also with proprioceptive sensations associated with the movements. As subjects flexed their hands and marched they had quite good adherence, especially in consideration of other exercises that required more fluid, less discrete movements.

Improved outcomes for vocal music were most strongly indicated in Exercise 6, rowing. These results were likely tied to the strong verbal cues of the song lyrics, *Row, Row, Row Your Boat,* which were apparent whether the song was performed vocally or instrumentally. Particularly with singing, the lyrics acted as verbal prompts to execute the rowing movements.

Generally, subjects stopped exercising during most songs and sang along during the majority of the vocal conditions. Concomitantly, they had less repetitions during the vocal condition which indicated poor adherence to the exercise regimen while they were actively engaged in singing along. Singing clearly distracted subjects from their exercise program and deleteriously affected their adherence. It was concluded that singing is contraindicated as a stimulus for exercise programs in persons who are likely to terminate exercise participation as they sing along.

As the exercise program was conducted, subjects spontaneously made comments that were noted by the investigators. A *post hoc* examination of these comments was made and the results are displayed in Table 1. Generally, subjects thought that the exercises helped with stiffness, mobility, range of motion, and breathing.

TABLE 1
Comment Categories

Comment content	Frequency
1. Positive experiences to music	$n = 8$
2. Negative experiences to music	$n = 1$
3. Positive experiences to exercise	$n = 5$
4. Positive experiences to exercising with music	$n = 5$
5. Music and exercise preferences	$n = 4$
6. Time perception experiences	$n = 6$
7. Increased comfort	$n = 2$

Furthermore, they found the music pleasant and liked having music in their exercise sessions. Only one comment indicated auditory discomfort associated with the trombone music. Even so, this subject preferred music over the no music conditions. Other subjects preferred singing over the trombone playing during exercises, but indicated no negative responses during sessions under the trombone condition.

This study did not make a strong indication for trombone and singing as music stimuli for improved exercise adherence in physical rehabilitation exercises; there is, however, some indication that music may influence certain exercise movements. Furthermore, it is possible that outcomes of this study were deleteriously affected by the data collection procedure which measured the numbers of repetitions rather than the frequency of time intervals in which subjects were appropriately engaged in the prescribed movements. Future research is recommended to determine the influence of strong, rhythmic pulsed, instrumental music as an enhancement for exercise adherence in older persons. Unfamiliar music, suitable to the speed and range of specific movements, will likely cause the least distraction, and consequently provide the best engagement and adherence.

Implications for Music Therapy

Among the health-care services available to elderly persons, exercise is essential to maintain physical function. Approaches that facilitate adherence to exercise regimens are therefore critical. In applications of music in clinical settings, there is indication that singing can function as a distractor, and is therefore not recommended to foster adherence in exercise. Instrumental music may influence adherence to exercise regimens; but, if it is familiar it

may also distract, and subsequently compromise adherence. Unfamiliar instrumental music with strong, imbedded metronomic beats is recommended.

Further research is necessary to determine the instrumentation, form, and delivery that yields the most efficacious outcomes. This study indicates some positive responses to external musical stimuli which may serve to facilitate exercise adherence, and provides a protocol that can be tested in future studies of the influence of music in exercise programs. Because subjects in this study verbally indicated their enjoyment of music in exercise, they may have good motivation to attend exercise sessions; however, this study was not designed to make such a determination. In this study, however, all subjects completed all experimental sessions willingly, and voluntarily attended subsequent sessions once their data were gathered. Indications are the music sessions may have some positive effects on attendance.

This study provides information which can facilitate the development of future research designed to determine the effects of music on exercise engagement and outcomes in older persons. This additional research may demonstrate more clearly the relationship between music enhanced exercise and improved physical function in populations of older adults.

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