THESIS

MUSIC FOR PHYSICAL REHABILITATION (1987-1996):

A LITERATURE REVIEW AND ANALYSIS

Submitted by

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY CHERYL ANN SCAPPATICCI ENTITLED MUSIC FOR PHYSICAL REHABILITATION (1987-1996): A LITERATURE REVIEW AND ANALYSIS BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF MASTER OF MUSIC.

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ABSTRACT OF THESIS

MUSIC FOR PHYSICAL REHABILITATION (1987-1996): A LITERATURE REVIEW AND ANALYSIS

A comprehensive literature review and analysis was conducted on the use of music for physical rehabilitation from 1987-1996. An earlier literature review and analysis of music for physical rehabilitation was published by Staum (1988), which covered the literature from 1950 -1986. The purpose of the current study was to provide music therapists with an updated and comprehensive resource to aid them in choosing effective treatment strategies for clients in need of physical rehabilitation. Pertinent music therapy sources, such as the Journal of Music Therapy, and pertinent non-music sources, specifically electronic bibliographic databases such as Medline, were consulted. Relevant sources were discussed in two chapters; Chapter 4 - An Overview of the Use of Music in the Treatment of Physical Rehabilitation, and Chapter 5- Clinical Implications for the Use of Music in Physical Rehabilitation . Tables containing frequency data supplement the discussion of the findings on treatment modalities, research settings, clinical population, musical applications, and literature sources. An overview of the methodology of all experimental and single-subject studies is provided in Table 8.

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CHAPTER 1

Physical Rehabilitation: Concepts and History

According to Garrison (1995), the focus of physical medicine and rehabilitation is on "the diagnosis and treatment of physical and functional disorders" (p. 1), which cover a wide spectrum of chronic disease and resulting disability. Included in this category are: cerebrovascular accident, neuromuscular disease, musculoskeletal disorders, traumatic brain injury, and spinal cord injury (Garrison, 1995; Kottke and Lehmann, 1990; Sinaki, 1993). The term chronic indicates that a condition is prolonged, and according to Kottke and Lehmann (1990) most chronic conditions involve multiple problems due to physical complications.

The main goal of physiatrists (physicians responsible for the coordination of therapeutic services), neurologists, and therapists in physical rehabilitation is to aid the patient in attaining the highest level of functioning possible and consequently, optimal quality of life (Kottke & Lehmann, 1990; Sinaki & Stillwell, 1993). Functional attainment can be placed on a continuum with three levels, in which each level is progressively built upon the others. The lowest level of attainment begins with the stabilizing of the cardiopulmonary system, the brain, and the regaining of consciousness. The moderate level includes improvement in sensory perception (awareness of surroundings), mobility, and achievement of everyday living skill. The highest level of functioning consists of vocational capability, and a desire for personal achievement and expression (Kottke and Lehmann, 1990).

Because of the sometimes complicated nature of chronic illness and disability, comprehensive treatment is the most common treatment strategy. The rehabilitation program is individualized, and may include a neurologist or physiatrist, physical therapist, occupational therapist, speech therapist, psychologist, and/or other adjunct therapists on the treatment team (Garrison, 1995; Kottke and Lehmann, 1990; Sinaki, 1993).

Research on the effectiveness of team care has yielded inconsistent results. While some studies have supported the method of team care (Feldman et al, 1962; Halstead, 1975; Spiegel et al, 1986 cited in Keith, 1991), others have yielded mixed results. For example, Wood-Dauphinee et al (1984, cited in Keith 1991) conducted outcome research with stroke patients in which results indicated that men experienced greater benefits in motor performance with team care, but women experienced greater benefits with traditional care. The results of Garaway et al's study (as cited in Keith, 1991) indicated that stroke patients who received team care were more independent at immediate discharge than those who did not receive it, however, there was no difference in independent status one year after discharge.

The inconsistency in team care procedures across rehabilitation centers has been noted as a possible confounding element in research, and the variation in team members based on patient need limits generalization of conclusions (Halstead, 1975). However, it is the coordination of interdisciplinary services based on patient need which has been viewed as the primary strength of comprehensive team care, and though the research findings on team care are inconclusive this modality of treatment remains the most widely used strategy for treating the disabled (Keith, 1991).

According to Cole (1993), the need for physical rehabilitation, as a specialty area, was first recognized by the American Medical Association (AMA) in response to the rehabilitation needs of World War I veterans. The American Congress of Physical Therapy, organized by the AMA, was founded specifically to educate civilian physicians in the physical strategies used effectively in the military hospitals. The AMA continued to support this new aspect of medicine by establishing the Council of Physical Therapy in 1925 (Cole, 1993).

The late 1930's marked a time of further organization, as well as an interest in the quality of physical rehabilitation. In 1937, the AMA recognized The American Congress of Physical Therapy as a medical specialty society. This was followed by the establishment of the American Registry of Physical Therapy Technicians, and development of a board of certification (Cole, 1993; Knapp and Kottke, 1988).

Research and clinical practice in physical rehabilitation increased in the 1940's. This was mainly due to the numerous physical injuries suffered by soldiers during World War II, as well as the physical impairments suffered by victims of the poliomyelitis epidemic in the United States (Cole, 1993; Kottke and Knapp, 1988).

Dr. Howard Rusk, an Army Air Corps physician and a founder of rehabilitative medicine, successfully advocated the use of an active form of rehabilitation in the recovery of wounded soldiers, as opposed to the more common practice of inactive convalescence which required a period of rest after an injury, disease, or surgery (Kottke and Knapp, 1988; Stedmann, 1995). Rusk conducted an experiment in which patients in one group received rehabilitative treatment while patients in a control group experienced inactive convalescence. Those patients involved in active rehabilitation were encouraged to walk as soon as possible after surgery. They also received physical therapy, recreational activities of varying physical involvement and, psychological support. The physical health and performance of the group which received active rehabilitation was "superior" to the group which experienced inactive convalescence. Consequently, the Air Corps ordered the initiation of rehabilitative services in all medical units (Kottke and Knapp, 1988).

According to Rusk, medicine involved three stages: preventive medicine, curative medication and surgery, and rehabilitation. His conviction of the importance of the third phase, rehabilitation, was stated as such: " Rehabilitation of the chronically ill and the chronically disabled... is a philosophy of medical responsibility. Failure to assume this responsibility means to guarantee the continued deterioration of many less-severely disabled persons..." (Cited in Kottke and Lehmann, 1990, pg. xxviii). In 1945, Rusk accepted the appointment of Professor of Rehabilitation at Bellevue Hospital, in New York City. It was at this establishment that a methodological assessment of ability for independent living was first developed and implemented (Kottke and Knapp, 1988).

During World War II, civilians in the United States experienced the devastating results of poliomyelitis, a disabling disease in which a virus infects the spinal cord, causing muscle pain, weakness, and eventual paralysis (Marieb, 1992). The number of cases increased rapidly from 7,300 victims in 1939 to 58,000 victims in 1952. In 1940, Sister Elizabeth Kenny, an Australian nurse, introduced innovative rehabilitation methods which increased the comfort and the level of functioning of polio patients. Kenny believed that muscular pain caused acute muscle spasms and, to combat this, advocated the use of hot compresses to relax the effected muscles; relaxing these muscles increased range of motion and decreased the occurrence of debilitating contractures. She also advocated the early and specific training of weak and/or improperly used muscles in order to maintain proper posture and function. With the support of physicians, Kenny was able to successfully demonstrate her treatment with 23 patients (Kottke and Knapp, 1988).

In response to polio patients' increasing need for rehabilitation services, the National Foundation for Infantile Paralysis funded training courses in which Kenny's treatment methods were taught (Kottke and Knapp, 1988). These rehabilitation techniques formed the basic foundation of current treatment for neuromuscular and musculoskeletal disorders (Martin,1988).

In the 1970's, the main research emphasis was in technology, benefits of team care, and cost effectiveness versus patient benefit. Basmajian et al (1975) studied the use of biofeedback in the retraining of motor control in stroke patients and observed positive results. Further support for the use of biofeedback in rehabilitation was provided by Brundy in 1976 (cited in Granger, 1988). In 1975, Halstead conducted a review of literature on the effectiveness of team care in chronic illness over a 25 year period. The results indicated that a majority of patients, who received team care, improved in their level of functioning compared with patients who received uncoordinated care from different medical disciplines. However, he cautioned generalization of his findings due to the inconsistency of team care provided to the patients. In the same year, Lehmann et al (1975) published a study conducted on the efficiency and cost effectiveness of rehabilitation with stroke patients. The results indicated that the patients experienced significant functional gains which could not be attributed completely to spontaneous recovery and that the benefits of rehabilitation decrease overall costs to society.

More recently, in 1990 the federal government demonstrated increased interest in rehabilitative research by establishing the National Center for Medical Research (NCMRR) (NIH, 1993). In 1992, the NIH funded the NCMRR with a budget of approximately 7.8 million dollars. This budget has increased annually to 18.5 million dollars for Fiscal Year 1996. The majority of funding over the years has been allotted to "priority areas" which include the following: career development and training, medical rehabilitation outcomes research, and research on the rehabilitation of persons with chronic disorders of the central nervous system (NCMRR Progress Report,1995,1996). According to Cole, this increased interest is in response to the increased need for effective rehabilitation services.

As of 1993, there were approximately 43 million Americans disabled and in need of rehabilitative services (NIH, 1993). According to Lehmann and Kottke (1990), this growing need for services is partially due to the increased success rate in acute surgical and medical care, as well as an increase in the life span of Americans.

Statistics project that the geriatric population will continue to increase into the next century. At present; 12% of the overall population in America is comprised of the elderly (Age 65 and older). This is projected to increase to 20% by 2030. At present those 75 years and older comprise 39% of the geriatric population, and this is projected to increase to 50% by 2030. (Garrison, 1995) After the age of 30, a person begins to experience a gradual decline in physiological processes. Pertinent to the field of physical rehabilitation are the decreases in muscle mass and elasticity, flexibility, and bone density. This physiological decline increases the chance of injury, and decreases the possibility of full recovery (Davis, 1992; Hong and Tobis, 1990 cited in Kottke and Lehmann, 1990). According to Hong and Tobis (1990), 45% of persons over the age of 65 experience some limitation in their activities of daily living and 60% of those persons over 85 years of age experience limitations in their daily living. Therefore, the main emphases in geriatric physical rehabilitation are the maintenance the physical functions of healthy elderly, and the assistance in regaining physical function from injury (Hong and Tobis, 1990). This will not only increase the need for physical rehabilitation services in the years to come but the types of services needed as well.

CHAPTER 2

Music Therapy in Physical Rehabilitation: Concepts and History

The official definition of music therapy, according to the National Association of Music Therapy, is as follows: "Music therapy is the use of music in the accomplishment of therapeutic aims: the restoration, maintenance, and improvement of mental and physical health..." (NAMT Sourcebook,1995). According to Bruscia (1989), music therapy is a systematic process, of which the client-therapist relationship is a vital part. The therapist assesses the client, develops a treatment plan with the client, and implements it in a purposeful and organized manner. Bruscia stated that music is implemented into the therapeutic process either as the "primary agent" of change, in which the music has a direct effect on the client, or as the facilitating agent, which augments the therapeutic relationship and leads to change (Bruscia, 1989).

In rehabilitation medicine, music is used both as the primary agent of change and as a facilitator. For example, music would be considered a primary agent when used to motivate and regulate pacing of physical exercise (i.e. set the speed of exercise repetitions), and considered a facilitating agent when used to encourage discussion of socio-emotional issues related to disability or injury. This study will focus on the use of music therapy in the physical aspect of rehabilitation, and therefore the use of music as the primary agent of change.

According to Thaut (1992), there are two approaches to music as therapy in physical rehabilitation: (1) movement to music; (2) movement through music. Movement to music refers to the use of music as "accompaniment for guidance and structure of motor activities" (Thaut, 1992, p. 174). The rhythmic aspect of music has been used to encourage the patient to initiate movement as well as maintain it, and the aesthetic qualities of music have been stated to lessen the monotony of repetitive exercise (Van de Wall, 1946). Thaut (1992) advocated music as an effective external timing cue in the retraining of motor coordination, with three advantages. (1) The rhythmic organization of music aids the patient in coordinating his/her movement in time by providing predictable rhythmic cues. (2) The auditory sense, through which music is processed, is the most accurate modality through which timing information is perceived. (3) Sound neurologically activates the motor system into a "state of readiness", which facilitates movement.

Movement through music is defined as "...the playing [of] musical instruments to exercise physical functions" (Thaut, 1992, p. 267) These physical functions include fine and gross motor coordination, range of motion, as well as respiration. For example, Clark and Chadwick (1980) presented documentation to support the successful use of wind instruments in the development of respiratory and oral muscular control, and the use of stringed instruments to improve fine motor coordination. Gaston (1968) advocated singing to increase vital capacity. Thaut (1992) emphasized three main advantages of movement through music. (1) Musical instruments give immediate and rewarding feedback to the patient involved in therapeutic exercise (auditory, tactile, and frequently visual). (2) The playing of musical instruments, if they are chosen according to patient preference and ability, may present the patient with an aesthetically pleasing and therefore rewarding task. This can be an effective motivating element in rehabilitative exercise. In reference to the use of music in rehabilitation Van de Wall (1936) stated the following: "The mind, bent on aesthetic expression, concentrates on efficiency rather than on deficiency, and the musculature follows suit and strives to attain the goal" (p. 252). (3) The rhythmic and melodic patterns that a patient learns while practicing his/her instrument aid in muscle memory, thus leading towards the more efficient learning of various combinations of movement.

The concept of music therapy in rehabilitation is not a new one. According to Taylor (1981), there were experiments demonstrating the effect of music on respiratory rate and volume at the turn of the century. In 1918, the first course in "musicotherapy" was taught at Columbia University by Margaret Anderton, a British musician. She taught this course based on techniques she had used while working with Canadian soldiers, who had been wounded in World War I. Anderton encouraged the soldiers suffering from orthopedic injury and paralysis to become actively involved in the music making process. Her technique was based on the premise that it was the actual timbre of musical instruments, which was responsible for the main "healing" effect of music. Six years later, in 1926, Hyde conducted research on the effects of vocal and instrumental music on the cardiovascular system (heart rate, blood pressure, blood flow, and electrocardiograph readings). She stated that music that stimulated "favorable" reflex actions in the cardiovascular system, could possibly render the same effects on other organs and functions of the body, including muscle tone (Taylor, 1981). In 1936, Van de Wall reported the possible stimulating effect of music on the motor system and its implications for rehabilitation, suggesting the use of music to physiologically stimulate motor response and exercise muscles. He also promoted the use of instrument playing for "motor practice" and "physical control". In 1938, Seymour and Parkman reported using adaptable instruments for children with orthopedic disabilities. Included in the documented case studies was a girl, born without her upper and lower extremities, who was first trombonist in the school orchestra, with the aid of adaptations (cuffs, rings, hooks, and zipper) (Taylor, 1981).

Interest in the therapeutic benefits of music increased during World War II, as military and civilian hospitals attempted to treat the physical and psychological wounds of service men and women. In reference to this heightened interest, Van de Wall stated, "Patients eagerly asked for music, hospital doors were wide open for those who wanted to come sing and play, and the musicians streamed in to render whatever service they saw fit to give" (Van de Wall, 1946, p. 8). In its efforts to incorporate music into hospital care, the United States Army Hospital Service formed the Program of Music in Reconditioning in

Army General Hospitals in the Continental United States (Van de Wall, 1946). One particular implementation of music into the reconditioning program consisted of synchronization of musical recordings to the cadence, rhythms, and lengths established for the physical reconditioning of patients (Ainlay, 1948). This use of music in rehabilitation emphasized the importance of matching the rhythm of the music to the movement abilities of the patients. The playing of wind instruments was also used in the strengthening of fine motor skills, and rehabilitation of chest injuries (Ainlay, 1948). Van de Wall (1946) supported the systematic use of music for correctional exercise emphasizing that patient preferred music should be used. Included in this systematic music program was the use of music to facilitate relaxation between exercises.

It is important to note that the development of music therapy as a physical rehabilitation strategy was implemented at the same time that physical rehabilitation strategies first came into use. Since then, music has been continually used in physical rehabilitation to increase motor coordination, range of motion, muscular control, and muscular and joint strength, as well as other functions (Ball et al, 1975; Cofrancesco, 1985; Denenholz, 1955; Josepha, 1964, 1968; Palmer, 1977; Rogers, 1968; Thaut, 1985, cited in Staum, 1988). This is a strong indication of music's usefulness in the field of physical rehabilitation.

In 1988, Staum published an in-depth literature review concerning the use of music in physical rehabilitation from the years 1950 to 1986. Her search yielded an impressive 390 occurrences of the use of music in physical rehabilitation, 85% of which were in the form of case studies and 15% of which were experimental studies. Music was specifically used in thirteen treatment modalities. The four main modalities in which music was used were neuromuscular coordination, movement/muscular stimulation, muscular/motor control, and muscular relaxation. The main clinical populations served by these four rehabilitation modalities were developmentally delayed and physically challenged children.

Movement exercises to rhythmic music were used in order to increase neuromuscular coordination, muscular stimulation, and muscular control. In most cases a specific rationale for the success of these techniques was not offered. However, the rhythmic/timing element of the music was indicated as facilitating the desired movements through offering immediate auditory feedback, structure, and motivation (Staum, 1988).

Passive listening to music was the most common technique used for muscular relaxation. Passive listening paired with electromyographic feedback resulted in significantly increased muscle relaxation over feedback alone (Scartelli,1982, cited in Staum, 1988). It has also been demonstrated that using music as emotional entrainment (modulating "tense" music towards "relaxing" music) effectively reduced EMG levels from baseline (Rider, 1985; cited in Staum, 1988). However, Staum (1988) cautions the generalizing of musical types ("tense" vs. "relaxing") across clinical populations due to the inconsistency of results.

Instrument playing, or movement through music, has also demonstrated success in increasing the previously stated functions, except muscular relaxation. The playing of rhythmic instruments and wind instruments have been successful in facilitating neuromuscular coordination and control through providing immediate auditory feedback. It has been suggested that the desire to create aesthetically pleasing music is an additional motivator. It has also been suggested that the changing tempi motivates movement, and the consistent nature of rhythm facilitates the initiation and termination of movement (Staum, 1988).

Staum's article is beneficial to therapists because of its organized and systematic presentation of not only the functions for which music was used, but also of the settings in which music was used, the specific injuries or disabilities for which it was used, and its effectiveness, based on the results of experimental studies. In comparing Staum's results with the most common findings of those therapists which initiated the use of music in physical rehabilitation, it is interesting to note that the four most common functions for which music was used were also some of the most common prior to 1950. Also the implementation of music therapy for those functions was similar. Staum (1988) suggested that further controlled research was necessary to substantiate the consistency of these methods which have appeared to facilitate rehabilitation.

CHAPTER 3

Rationale and Methodology

Statement of the Problem

At the time of Staum's article there was an increasing use of music for its therapeutic benefits in physical rehabilitation. However, it still was not being "integrated on a widespread clinical basis" (Staum, 1988, p. 84). According to the National Association of Music Therapy statistics for 1997, the number of music therapists serving populations that may benefit from the use of music in physical rehabilitation has been increasing; the populations included medical/surgical, neurologically impaired, multiply disabled, physically disabled, Rett Syndrome clients, comatose, head injury, Parkinson's, and Cerebrovascular Accident (NAMT Sourcebooks, 1992-1995, 1997). Based on the information received from survey respondents there has been a gradual increase from 13% of music therapists serving these populations in 1992 to 19% in 1997. Also, those populations designated as "other" by NAMT in 1997 included cerebral palsy, Huntington's Chorea, multiple sclerosis, post surgery, and spinal cord injury, all of which could possibly benefit from the use of music in physical rehabilitation (NAMT, 1997).

As stated previously, the need for rehabilitation services has been increasing, and will increase into the next century (Kottke and Lehmann, 1990; Cole, 1993, Garrison, 1995). As music therapists continue to respond to this need, it is of utmost importance that they have access to updated, pertinent literature on the use of music in physical rehabilitation. Currently, there is no documented, comprehensive synthesis and analysis of literature pertaining to the use of music in physical rehabilitation from the years 1987 to 1996.

Statement of Purpose and Rationale

The purpose of this study is to provide music therapists with a comprehensive synthesis and analysis of literature pertaining to the use of music in physical rehabilitation from the years 1987 to 1996. This resource will aid therapists in choosing effective treatment strategies, as well as providing an awareness of populations which benefit from the use of music and those which seem not to benefit.

Methodology

The method for identifying and analyzing literature pertaining to music and physical rehabilitation is based on the approach that Staum used in her 1988 study "Music for Physical Rehabilitation: An Analysis of the Literature from 1950-1986 and Applications for Rehabilitation Settings". In the investigation she analyzed articles from music therapy and non-music therapy sources to determine the musical applications that were applied to therapeutic modalities. Based on this research, Staum (1988) developed a detailed classification system that included such categories as setting, primary disability, therapeutic goals, music applications, and benefits from treatment.

Delimitations

The proposed literature review will be delimited to books, articles, master's theses, doctoral dissertations, and other published reports on the use of music in physical rehabilitation. In keeping with Staum's literature analysis, the following types of studies were excluded: simulation studies (studies in which disabilities are imitated), developmental learning of motor or imitative skills, improvement of self help skills, reduction of hyperactive or stereotypical behaviors, and the adverse use of auditory stimuli (i.e. tone avoidance feedback). Studies of healthy individuals were excluded in Staum's study (1988), but were included in the current study due to the possible implications for therapeutic benefit.

Sources Consulted

For the current study, the researcher examined all pertinent music therapy sources and pertinent extramusical sources from 1987 to 1996 to identify studies which discussed the use of music in physical rehabilitation. The scope of the literature search was based on Staum's (1988) search strategy, which included sources in music therapy and music education, physical therapy and special education, medical and nursing, and psychology and motor learning.

The pertinent music therapy sources consulted were the Journal of Music Therapy, Music Therapy Perspectives, Music Therapy, and the British Journal of Music Therapy. As well as any pertinent subject bibliographies found in the sources. The Journal of Music Therapy is a journal of the National Association for Music Therapy and contains articles pertaining to research in laboratory and clinical environments. Music Therapy Perspectives is also a journal of the National Association of Music Therapy, which contains articles on the application of music therapy within clinical settings. Music Therapy is the journal of the American Association of Music Therapy, which contains articles on the research and clinical use of music therapy. The British Journal of Music Therapy, which is the journal of the Association of Professional Music Therapists and the British Society for Music Therapy, contains mostly articles on the clinical use of music within the therapeutic environment.

The majority of pertinent extramusical sources were found in the following electronic databases: 1) Medline, 2) PsychINFO, 3) ERIC, 4) Dissertation Abstracts, 5) FirstSearch (WorldCat & ArticleFirst), and 6) Cumulative Index of Nursing and Allied Health. Subject bibliographies of pertinent articles were also searched. The rationale was to consult the databases most specific to the topic of physical rehabilitation first and then consult the more general databases to obtain any extraneous sources. For instance, several master's theses were found in WorldCat but not in Dissertation Abstracts. A brief description of each database consulted is provided:

1) Medline - This is a bibliographic database that is compiled by the National Library of Medicine dating back to 1966. It contains citations of approximately 3800 journals that are published in the U.S. and approximately 70 journals from other countries. It covers the fields of medicine, nursing, dentistry, and health care, as found in the Index Medicus, Index of Dental Literature, and International Nursing Index (National Medical Libraries, [on-line], 1997).

2)PsychINFO - This bibliographic database contains approximately 1300 journals from the U.S. as well as international journals that have been compiled from 1967 to current. Its scope consists of journals, books, dissertations, and technical reports in the fields of psychology, psychiatry, medicine, nursing, sociology, physiology, and linguistics (APA, [on-line], 1997).

3) ERIC - This bibliographic database contains over 800,000 references to journal articles, books, theses, conferences, and reports from 1966 to present. Its sources are Resources in Education and the Current Index to Journals in Education. This also contains the Music Educators Journal and the Journal of Research in Music Education which is published by the Music Educators National Conference (ERIC cover page, [on-line], 1997).

4) Dissertation Abstracts - This database cites more than 1,300,000 doctoral dissertations and master's theses that date back to 1861. It is compiled from four UMI dissertation publications: Comprehensive Dissertation Index, Dissertation Abstracts International. Master's Abstracts International, and American Doctoral Dissertations (Dissertation Abstracts Introduction, [CD-ROM], 1997).

5) WorldCat (in FirstSearch) - This database covers "over 36 million records of any type of material catalogued by OCLC member libraries" worldwide (Cover page of WorldCat [on-line], 1997). These records date from the eleventh century to the present and are updated daily.

6) ArticleFirst (in FirstSearch) - This database covers approximately "12,500 journals in science, technology, medicine, social science, business, the humanities, and popular culture"(Cover page of ArticleFirst [on-line], 1997). It covers the years from 1990 to the present and is updated daily.

7) Cumulative Index of Nursing and Allied Health Literature (CINAHL) - This database covers approximately 900 journals on nursing, allied health, biomedicine and consumer health, as well as publications of the American Nursing Association, and the National League for Nursing (Cover page of CINAHL [on-line], 1997).

Search Strategy

The search strategy for the electronic databases consisted of four steps. First, appropriate keywords were identified through the consultation of the following sources: Medical Subject Heading published by National Library of Medicine, Thesaurus of Psychological Index Terms published by the American Psychological Association, Thesaurus of ERIC Descriptors, Library of Congress Subject Headings, and the electronic thesaurus of Dissertation Abstracts and CINAHL. Table 1 lists all of the "music" key words and the main rehabilitation key words used in the search. Secondly, the most efficient and thorough use of the terms was determined. For the majority of databases the use of subject headings and sub-headings yielded the most thorough search of the literature. A slightly different strategy was used with Medline and PsycINFO; in addition to subject headings, textwords were consulted as well as words found in abstracts and titles. For all databases the search started with the most general terms and progressed to specific terms. The use of the conjunctions "and" and "or" (referred to in database searching as Boolean Operators) significantly increased the efficiency of the searches by allowing the combining of terms, exclusion of terms, and/or the searching of many related terms at once; for example acoustic stimulation or music, music therapy or music and therapy, music and hemiplegia. Thirdly, all citations were limited to the English language and the years of 1987 to 1996. Fourth, the abstracts and citations were reviewed based on the previously stated delimitations.

Organization and Presentation of Data

Data was tabulated on the frequency of occurrences of the following topics found in the literature: treatment modality (rehabilitative strategy), target area (upper/lower extremities), research setting, clinical population, musical application, research trends, and literature sources. All of the topics, except for target area and research trends, were addressed in Staum's(1988) literature review and analysis of music for rehabilitation from 1950 -1986. The use of these topics was to allow for comparisons to be made from the findings in Staum's(1988) literature review and the findings of the current literature review. The tabulated data were placed in tables that represent the frequency distribution of the previously stated topics. An overview of the use of music with the treatment modalities (i.e. neuromuscular coordination, neuromuscular control) found in the literature from 1987 to 1996 was presented. This was followed by a discussion of clinical implications organized by setting, clinical populations, musical applications, and research trends. (Tables are included within the text).

Table 1 Key Words

Music/Auditory Terms	Rehabilitation Terms
Acoustic Stimulation	Airway Resistance, Breathing, Respiratory Mechanics, Work of breathing
Auditory Biofeedback, Cueing, Perception, Stimulation	Ambulation, Gait, Locomotion
Creative Arts Therapy	Balance, Posture
Music	Brain Damage, Head Injury
Music & Education	Cerebrovascular Accident, Stroke
Music, Influence of	Child, Pediatrics
Music & Reinforcement	Developmental Delays, Mental Retardation
Music Therapy	Disabled, Physical Disability, Physical Handicap
Rhythmic Auditory Stimulation	
Sensory Cueing, Feedback, Stimulation	Physical Education, Physical Training, Physical Endurance, Physical Strength
Sound	Exercise Therapy, Occupational Therapy, Physical Therapy, Rehabilitation, Therapeutics
	Geriatrics
	Hemiplegia, Paralysis
	Huntington's Chorea
	Lower Extremities (leg, hip, knee, thigh)
	Lung Diseases; Lung Diseases, Obstructive
	Motor Activity, Motor Skills, Motor Development, Psychomotor Performance
	Movement Disorders, Muscular Disease, Skeletal Disorders
	Osteoarthritis, Rheumatoid Arthritis
	Parkinson's Disease
	Upper Extremities (hand, elbow, arm)

CHAPTER 4

An Overview of the Use of Music in the Treatment of Physical Rehabilitation

As stated previously, the main goal of physical rehabilitation is to aid the patient in attaining the highest level of functioning, and the highest quality of life possible (Kottke & Lehmann, 1990). According to Kottke and Lehmann (1990), the highest level of functioning consists of vocational capability and the desire for personal achievement and expression. The use of music in physical rehabilitation allows clients to achieve the highest level of functioning possible by promoting independence, personal achievement, and expression while working on the rehabilitation of specific disabilities (i.e. improvement of neuromuscular coordination , muscular endurance, etc.).

The purpose of this literature review and analysis is to provide music therapists with a comprehensive resource to aid in the choice of effective treatment strategies for clients in need of physical rehabilitation. The goal of this chapter is to assist the reader in choosing effective treatment strategies by presenting an overview of the use of music in physical rehabilitation within the following seven treatment modalities identified in the literature from 1987 to 1996: neuromuscular coordination, compliance with treatment, respiratory rehabilitation, neuromuscular control, muscular endurance, muscular relaxation, and muscular stimulation (see Tables 2 & 3). This overview includes definitions of each treatment modality, the populations that were studied within each treatment modality, the target area (or area of the body that was focused on) during rehabilitation, the music applications used, the rationale for their use, and their effectiveness.

Table 2 Frequency of Treatment Modalities

Treatment Modality	Experimental	Single Subject	Case Report	Total
Neuromuscular Coordination	14	4	0	18
Compliance with Treatment	1	8	2	11
Respiratory Rehabilitation	6	1	1	8
Neuromuscular Control	5	0	1	6
Muscular Endurance	4	1	0	5
Muscular Relaxation	2	2	1	5
Muscular Stimulation	2	2	1	5

More than one treatment modality may be researched in a single study.

Table 3 Frequency of Target Area

Target Area	Experimental	Single Subject	Case Report	Total
Lower Extremity	19	5	4	28
Upper Extremity	7	9	3	19
Trunk	1	6	2	9

More than one target area may be studied in a single study.

Neuromuscular Coordination

The term neuromuscular coordination has been defined as follows:

> ... the process that results in the activation of patterns of contraction with many motor units of multiple muscles with appropriate forces, combinations, and sequences, and with simultaneous inhibition of all other muscles in order to carry out the desired activity. (Kottke, 1990, p.452)

These complex processes are continuously being executed in all movements of healthy individuals; walking, eating, reaching for clothes, etc. It is believed that these processes are executed via the motor program which is responsible for the selection and integration of submovements towards a specific goal, via the "selection, ordering, timing, and parameterization" of neural mechanisms (Summers, 1989, p. 64).

The rehabilitation of neuromuscular coordination involves the "retraining" of damaged neural mechanisms involved in the affected motor program (Thaut, 1992). According to Kottke (1990), this involves prescribed exercises that are repetitive, exact, and focus on the precise execution of movement patterns. Kottke (1990) states that this kind of exercise forms engrams or "preprogrammed patterns of activity" which with time and repetition will become automatic or coordinated.

The majority of studies on the effect of music on neuromuscular coordination focused on gait rehabilitation. The most frequent populations documented were Parkinson's Disease, Cerebrovascular Accident, and Normal Gait. The main musical application used for this type of rehabilitation was movement to music, in particular, rhythmic auditory stimulation (RAS).

Rhythmic Auditory Stimulation is a technique which uses a strict auditory rhythmic pattern, either embedded in music or via metronome, as an anticipatory cue for muscular activation and coordination. This technique, developed by Thaut (1992), is based on the premise that the auditory rhythmic pattern provides predictable timing information which aids the patient's gait by facilitating an anticipatory movement strategy. It is hypothesized that the phenomenon which underlies this process is the strong influence of the external auditory rhythm on the internal timing mechanisms involved in gait patterns. This is manifest in an actual synchronization of the client's step with the auditory cue, an entrainment effect (Thaut et al, 1992; Mezza, 1994).

Rhythmic Auditory Stimulation has yielded immediate significant improvements in the gait of patients with a diagnosis of Cerebrovascular Accident, Parkinson's Disease, Traumatic Brain Injury (Thaut et al 1993; Thaut et al 1994; Hurt, 1996). Improvement has also been observed in the gait of one individual with a Cerebellar Disorder and one individual with Transverse Myelitis (Thaut et al, 1992). Additionally, RAS has been observed to significantly effect the quality of gait in healthy individuals (Thaut et al, 1992). Significant improvement in gait has also been observed after prolonged training programs with individuals suffering from Parkinson's Disease and TBI (Hurt, 1996; Miller et al, 1996; Thaut et al, 1996).

One study using RAS with an elderly population indicated the presence of a significant entrainment in gait (Mezza, 1994); however, RAS seemed to have no prolonged significant effects on the gait of healthy elderly people, after a three week training program (Brault, 1995). Musical applications similar to RAS have also yielded improvements in the gait patterns of individuals with acute orthopedic conditions (Holdren, 1991), Parkinson's Disease (Enzensberger & Fischer, 1996), and cerebral palsy (Holliday, 1987). Electromyographic data from Thaut's and Miller's studies indicated that RAS decreased neuromuscular variability, and increased neuromuscular symmetry and timing via a more efficient and stronger muscle recruitment process (Thaut et al, 1992; Thaut et al, 1992; Thaut et al, 1993; Thaut et al, 1996; Miller et al, 1996).

The main beneficial effect of music cited in the literature was the apparent structuring of movement through consistent and predictable timing information (Holliday, 1987; Holdren, 1991; Thaut, 1992; Mezza, 1994; Enzensberger & Fischer, 1996). These results are congruent with the views of Kottke (1990) and Holding (1989) on the rehabilitation of neuromuscular coordination. As stated earlier, coordination may be improved through the precise execution and repetition of preprogrammed patterns of activity (Kottke, 1990). According to Holding (1989) "...the most predictable skilled tasks ...yield best learning and performance" (p. 13).

There have been two studies on the effect of RAS in upper extremity fine motor timing. Rathbun (1995) investigated the effect of a rhythmic stimulus embedded in music over a rhythmic stimulus only (metronome) on the fine motor timing of healthy college and elderly populations at different tempi or frequencies, specifically the synchronization of a finger tap with the auditory stimulus and variability of the motor response. Results indicated that both healthy college students and healthy elderly significantly improved in positional accuracy in the music condition, over the rhythmic stimulus only condition in all but the slowest and fastest frequencies. No significant difference was observed between the two conditions on variability of motor response. Joichi (1996) found that an individual with a traumatic brain injury experienced significant improvement in fine motor timing in both music and rhythmic stimulus only conditions. Rathbun (1995) speculated that the additional music context provided individuals with additional and beneficial timing information. One study was conducted which tested the effect of RAS on gross motor coordination of the upper extremities at a faster and slower tempo. Results indicated a significant increase in the duration of triceps activity before target contact for both rhythmic conditions, a significant increase in duration of biceps activity after target contact in the slower rhythmic condition, and a significant increase in the length of cocontraction of the triceps and biceps for both rhythmic conditions (Thaut et al, 1992).

Compliance with Treatment

Compliance has been defined as "... the extent to which a person's behavior (in terms of taking medications, following diets, or executing life style changes) coincides with medical or health advice" (Haynes, 1979 as cited in Thurmond, 1990, p. 5). Compliance is an extremely important issue in rehabilitation. The effectiveness of a prescribed therapy depends on the client's willingness to participate in his/her treatment, whether it consists of medication, exercise regimens, or lifestyle changes.

The majority of documented studies were concerned with possible effects of music on the compliance of individuals with developmental disabilities. Physical rehabilitation is often a major element of this population's educational experience (Silliman, 1992). Unfortunately, disruptive behavior often hinders the benefits of physical and occupational therapy (Silliman, 1992). Therefore, an effective reinforcement procedure, which promotes the compliance of an individual with the therapeutic goals of physical and occupational therapy, is considered to be an integral part of the rehabilitation process. Six studies investigated the effects of music on compliance with treatment of individuals with developmental disabilities.

The main therapeutic concern documented with this population was the attainment and maintenance of head and upper body posture. The musical application most frequently used was contingent music, which yielded consistent improvement in head and upper body posture (Burch, 1987; Silliman, 1992; Silliman, 1993; Sullivan, 1994) as well as training in gait and balance (Holliday, 1987; Strawbridge, 1989).

The effectiveness of compliance was also investigated in patients with osteoarthritis, spinal cord injury (SCI), and traumatic brain injury (TBI). Research on the populations with osteoarthritis and SCI emphasized compliance with therapeutic exercise. Movement to music was used in both osteoarthritis studies, yielding improvement in one (Thurmond, 1990) and no noticeable improvement in another (Bernard, 1994). Apkarian (1991) observed positive results from converting a patient's fine motor (hand grasping) exercise into music through the transducing of muscular impulses into sound. The results of Kearney and Fussey's (1991) experiment indicated that the use of contingent music significantly increased the correct head posture of a patient with TBI.

The main reason cited for the observed success of music with all populations mentioned is its ability to motivate the various individuals through pleasurable experience (reward) (Burch, 1987, Holliday, 1987, Strawbridge, 1989, Thurmond, 1990, Apkarian, 1991, Kearney & Fussey, 1991, Silliman, 1992, Silliman, 1993, Landrieu-Seiter et al, 1995).

RespiratoryRehabilitation

" The lung is for gas exchange. Its prime function is to allow oxygen to move from the air into the venous blood and carbon dioxide to move out" (West, 1985, p.1). This function of the lungs is two fold, consisting of ventilation (inhalation and exhalation) and diffusion (the actual exchange of oxygen from the air sacs to the blood and of carbon dioxide out of the blood) (West, 1985). The use of music has been investigated in the rehabilitation of pulmonary disorders involving both ventilation and diffusion.

The term Chronic Obstructive Pulmonary Disease (COPD) is defined in Dorland's Illustrated Medical Dictionary as " any disorder...marked by obstruction of bronchial air flow" (p. 480, 1994). In this study the disorder of COPD is divided into conditions which are chronic and deteriorating, and asthma which is also chronic yet consists of acute episodes of bronchoconstriction, resulting from increased responsiveness of the trachiobronchial tree to stimuli (Corbridge, T. & Irvin, C., 1993). The main goals in rehabilitation of both of these disorders are the "decrease of the physical and psychological manifestations of the underlying disease" and " an increase in physical and mental fitness and performance" (Folgering, Dekhuijzer, Cox, & Herwaarden, 1993, p. 22). Two studies investigated the effects of different music modalities on the physical and psychological manifestations of asthma. Three studies focused on the use of music to decrease the physical manifestations of the COPD.

Lucia (1993) conducted a short term survey examining the effects of wind instrument playing vs. no instrument playing on frequency and severity of asthma symptoms (subjects were not matched but were comparable in terms of asthma severity). Results indicated no significant difference between the two groups during the month long survey, yet a General Health Profile, which assessed overall health and severity of asthma symptoms, indicated that wind instrumentalists experienced asthmatic symptoms significantly less frequently and less severely than non-instrument players. Lucia suggests that this discrepancy might be due to the short duration of the study. Lehrer et al (1994), examined the effect of music listening vs. progressive relaxation on overall relaxation of the subjects and the consequent bronchoconstriction of asthma patients. It was concluded that the resulting relaxation effect of both music listening and progressive relaxation had an adverse effect on bronchoconstriction.

Griggs-Drane (1989) observed no difference between wind instrument playing and inspiratory muscle training on the pulmonary function of moderate COPD patients. However, those who played wind instruments as therapy demonstrated an increased awareness of correct breathing technique and posture along with increased enjoyment and compliance with treatment compared with inspiratory muscle training. Therefore, this study indicated that wind instrument playing was a viable and possibly more practical alternative in maintenance therapy for some COPD subjects.

Two studies investigated the effect of music listening on perception of dyspnea (difficulty of breathing) and physical endurance in COPD subjects. Results indicated that music listening during exercise significantly reduced the perception of dyspnea and increased exercise tolerance (Thornby et al, 1995), and music listening after 6 minutes of mild/moderate exercise significantly reduced the subject's respiratory rate compared with no music, though it had no significant effect on dyspnea perception (Sidani, 1991). Thornby suggested that music's positive effect in these two areas was possibly due to its distracting qualities.

The remaining three studies focused on two respiratory disorders which adversely effect the diffusion capabilities of premature infants; Infant Respiratory Distress Syndrome (IRDS) and Bronchopulmonary Dysplasia (Horowitz & Davis, 1997). The inability to deliver adequate oxygen to the blood causes the infants to put forth a greater respiratory effort for less gain, which often leads to hypoxemia and dyspnea (Horowitz, & Davis, 1997). Two studies investigated the use of music listening on the respiratory rate and oxygen saturation of the blood in infants with IRDS, and found no significant difference between music and no music conditions (Rose, 1987, Loggers, 1993). Contrary to these studies, Zellmer (1989) discussed a case study in which music listening noticeably increased the oxygen content of the blood, and decreased the respiratory rate of an infant with Bronchopulmonary Dysplasia. It was also noticed that rhythmic tactile stimulation along with the music decreased distress during chest percussion, a method frequently used to loosen excess airway secretions for expectoration (Faling, 1993).

A main contributing factor in the outcomes of these studies could be the type of music used. Rose (1987) and Loggers (1993) used music with varying tempos and dynamic levels. According to Loggers, this resulted in observed restlessness. Zellmer

(1989) chose a tape of lullabies, paying special attention to find and use songs which induced positive states in the infant.

Neuromuscular Control

Staum (1988) divided this category into two types of motor control. The first was defined as a combination of both coordination and strength (i.e. ability to manipulate one's arms , shoulders, fingers, etc.). The second referred to the patient's ability to isolate and move a small number of muscular units at will (e.g. the contracting of knee flexors, the isolation of one finger, etc.). The studies on neuromuscular control between 1987-1996 focused only on the patient's ability to isolate and move small muscular units at will.

According to Kottke (1990), the ability to control individual muscles or small muscular units is the first and most crucial step in the development of motor coordination of multiple muscular units. According to Kottke, "control involves conscious and continuous awareness and intentional guidance of an activity" (Kottke,1990, p.452). This is primarily facilitated through kinesthetic and proprioceptive feedback. It is suggested that auditory feedback may augment this through providing the patient with immediate knowledge of performance (Olney et al, 1989, Engardt et al, 1993).

All of the studies conducted between 1987-1996 investigated the effect of combining auditory feedback and electrical monitoring devices on the muscular control of cerebrovascular accident patients. The emphasis of these studies was divided between the improvement of knee flexion (Basaglia et al, 1989, Olney et al, 1989, Morris, 1992) and the facilitation of body symmetry (body weight and muscular force) in rising and sitting (Engardt et al, 1993, Engardt, 1994, Fowler et al, 1996).

The use of auditory feedback combined with electrogoniometry (an electric monitor for the detection of range of motion) yielded a significant decrease in knee hyperextension for two cases (Basaglia, 1989, Morris, 1992) and an increase in knee flexion for another (Onley, 1989). The correction of both these conditions is important. Stroke victims often hyper-extend the knee of their paretic side for compensatory support during standing as well as the stance phase of gait (Basaglia et al, 1989, Morris et al, 1992). This leads to faulty body mechanics resulting in distorted afferent messages concerning proprioceptive information (Basaglia et al, 1989). Consequently, this leads to a chronic and aberrant gait pattern (Basaglia et al, 1989). Along similar lines, a stroke victim may experience a decrease in range of motion of the affected knee during gait. This may lead to the shifting of one's weight to the non-affected hip, leading to balance problems, as well as arthritis (Olney et al, 1989).

Three studies investigated the use of auditory feedback combined with electronic weight distribution monitors on the weight symmetry of the lower extremities while sitting and standing from a seated position. Fowler et al (1996) observed no significant difference between the experimental and control groups in weight symmetry during standing. Engardt et al (1993) found that an experimental group using this combination of treatment improved the weight distribution on their affected leg significantly more than the control group during sitting and standing. This improvement also seemed to carry over into physical performance tasks. Unfortunately, a follow-up study 33.5 months post treatment indicated that the same experimental group declined significantly more than the control group (Engardt, 1994). Engardt suggested that this may have resulted from an over dependence on the auditory feedback within an experimental setting, thus inhibiting the subjects ability to attend to internal feedback. It was suggested by Engardt (1994) that an integration paradigm be investigated; decreasing the auditory feedback throughout the initial treatment, and integrating auditory feedback into daily activities (Engardt, 1994).

Muscular Endurance

In general terms endurance is " the ability to continue a specific task" (Lateur & Lehmann, 1990,p 481). The main objective of endurance exercise is to lengthen the time in which an individual can partake in a specific muscular task, thus increasing his/her therapeutic benefit (Lateur, & Lehmann, 1990). The use of music listening to facilitate muscular endurance was of particular interest to Staum (1988). At the time of Staum's literature review only one experimental study had been conducted on the use of music to facilitate muscular endurance. In response to the lack of research in that area Staum stated the following: "... it would be interesting to determine whether background or paired music (with action) might exceed muscular fatigue points when compared with the absence of music" (p.76).

The majority of studies between 1987-1996 focused on increasing empirical evidence of music listening on muscular endurance in healthy individuals. Several different types of music listening were investigated. Beckett (1990) and Copeland et al (1991) found that college aged subjects experienced a longer time to exhaustion while walking to music vs. no music. Copeland's results indicated that soft, slow, and popular music resulted in a significantly longer time to exhaustion than fast and loud music. Beckett's results indicated that listening to music intermittently was "slightly" more effective in attenuating the perception of exhaustion than listening to music continuously. Beckett (1990) and Copeland (1991), both suggested that music's effectiveness was possibly due to its distracting qualities; "the external attentional focus (i.e. the focus induced by the music) may have attenuated internal sensations of exertion" (Copeland, 1991, p.103). Papa (1988) investigated the effect of music listening prior to performance of an upper extremity task with a similar population and observed no significant difference between stimulative, sedative, and no music conditions. However, it was observed that stimulative music significantly increased muscular strength. Papa (1988) gave no explanation for this phenomenon. One study investigated the effect of music listening on upper extremity muscular endurance of healthy elderly subjects and yielded no significant results (Cilento, 1996).

Johnson (1989) examined the effects of movement to live music on upper extremity muscular endurance in subjects diagnosed with CVA, TBI, and SCI, and observed a significant increase in muscular endurance of all three subjects in the music condition vs. no music condition. Johnson (1989) also observed similar results in using movement through music (instrument playing) with another CVA subject. In explaining these results, Johnson discussed the ability of music to distract subjects from physical discomfort. However, she also stated that the timing and structure of music possibly had a positive neurophysiological effect on the muscles, which facilitated more effective and longer exercise sessions (Johnson, 1989).

Muscular Relaxation

Muscular relaxation is defined in The American Heritage Dictionary as " The lengthening of inactive muscle or muscle fibers " (1985, p.1043). This was of concern in patients with spastic cerebral palsy and traumatic brain injury, with emphasis placed on increasing range of motion and inhibiting muscle spasm (Pollack,1988, Grundy, 1989, Skille et al, 1989, Kline, 1993). The ability of these patients to move their limbs and inhibit muscle spasm is directly related to their quality of life, determining the extent to which they can function independently in activities of daily living.

In Staum's (1988) literature review and analysis a variety of musical applications were used to promote relaxation. Examples include the use of music and biofeedback to reduce muscular tension, movement to music, and the use of the isoprinciple, modulating from "tense" music to "relaxed" music to encourage relaxation. In contrast, the currently documented studies all focused on the effect of passive music listening on muscular relaxation. Pollack (1988) investigated the effects of sedative music vs. stimulative music vs. no music conditions on the hypertonicity of spastic cerebral palsy children. Results indicated that music in general elicited varied responses from the subjects contributing to reduction of muscle tension and improving movement and posture in some, while contributing to the deterioration of these same characteristics in others. No significant difference was observed between the effects of sedative vs. stimulative music. Kline's (1993) study indicated that quiet classical music alone and music combined with neutral warmth (a technique used to facilitate relaxation via the containment of one's own body heat) significantly increased elbow range of motion in spastic cerebral palsy subjects, compared with neutral warmth alone and no music conditions. Kline (1993) attributed the music's facilitating properties to its promotion of independent movement and its familiarity as a medium.

Vibroacoustic therapy is a relatively new music application which involves the transfer of musical vibrations through a chair directly to the body. This allows the patient to listen to music and physically experience it simultaneously (Skille et al, 1989). Skille, the inventor of vibroacoustic therapy, states that low frequency tones (40Hz-80Hz) have a "spasmolytic effect on muscle tissue" (Skille et al, 1989, p. 7), and cites several cases in which it has appeared that vibroacoustic therapy facilitated the decrease of muscle spasm and consequent increase in range of motion in patients suffering from cerebral palsy and rheumatoid arthritis. Grundy (1989) studied the effect of music and vibration vs. music listening alone on the hypertonicity of CVA and TBI patients. Results indicated that neither music application had a significant effect.

Muscular Stimulation

The definition of stimulate, according to The American Heritage Dictionary, is "to rouse to activity or heightened action" (1985, p. 1197). Therefore, muscular stimulation may be defined as the action of exciting the muscular system to increased activity. In this category Staum (1988) documented studies which ranged from stimulating exercises for large muscle groups to minute muscular movements of non-responsive patients. It has been the latter group, specifically comatose patients, with which the previous literature has been concerned.

The majority of studies between 1987-1996 discussed the importance of sensory stimulation in the rehabilitative process of comatose patients. Aldridge (1990) emphasized the importance of maintaining human contact with the patient through verbal communication and sensory experiences in order to counteract the sterile and mechanical environment of intensive care units. Jones (1994) stated a current rationale for the use of sensory stimulation with comatose patients: "... even in persons with damaged nervous systems, exposure to frequent and varied sensory stimulation facilitates dendrite growth and improves synaptic connectivity. Consequently, sensory stimulation may enhance a patients cognitive functioning and environmental awareness and interaction" (p. 164). It has also been stated that sensory stimulation, familiar to the patient, may facilitate recall or relations between the stimulation and past experiences (Wilson, 1992).

The results of Sisson's (1990) and Wilson's (1992) studies reflected the individual differences of comatose patients. The investigators chose different types of musical stimuli; Sisson chose popular music for her subjects to listen to, whereas Wilson played the musical preferences of her subjects. However, their results were similar in that the music selections seemed to arouse behavioral responses (eye opening, arm and head movements etc.) in some subjects, while observing no responses in others. One patient in Wilson's study showed no significant response to any auditory stimuli, which brings up the important fact that the type of sustained damage is a major factor in the choice of sensory stimulation. Jones (1994) investigated the effects of listening to taped auditory stimuli, and extended this to include the voices of family and friends and nature sounds along with two types of music (classical & rock). Her results indicated that family and friends yielded significantly more observable behavioral and physiological changes than the other stimuli. It puzzled Jones that the subject did not respond at all to rock music, especially since it came from that individual's own collection. Her rationale for these results was that the apparent increase in responses to the taped voices of family and friends seems to support the importance of family contact, the subjects unresponsiveness to the rock music could have been due to the decibel level of the music or to habituation because of its familiarity. Grundy (1989) and Aldridge (1990) documented the most unique uses of music listening on muscular relaxation. Grundy (1989) investigated effects of music listening only vs. music vibration on the relaxation responses of individuals. Results indicated no significant differences for either physiological (EMG) or behavioral arousal. Aldridge (1990) documented a case study in which the therapist improvised her singing around the breathing rhythm of each subject, thus involving the subject in the musical experience. Responses of the subjects included fine motor movement, head turning, and slower, deeper breathing patterns.

The consistent accounts of observed subject responses to the auditory stimuli across studies strongly suggests that this form of stimulation can be used successfully in the rehabilitation program of certain individuals. However, the variability of observed subject responses within and across the individual studies indicates the unpredictable nature of comatose states, and stresses the importance of observation and flexibility in the selection of musical/auditory stimuli.

CHAPTER 5

Clinical Implications for the Use of Music in Physical Rehabilitation

As stated in Chapter 4, the purpose of this study was to provide music therapists with a comprehensive resource to aid in the choice of effective treatment strategies for individuals in need of physical rehabilitation. The goal of this chapter is to provide the reader with clinical implications, presented in the form of a comparative analysis of Staum's (1988) findings from 1950 - 1986 and the current findings from 1987-1996. The topics discussed are research settings and clinical populations, musical applications, and research trends.

Settings and Clinical Populations

There were two main similarities observed in the research settings identified in both Staum's (1988) literature review and the current literature review. First, the nine research settings identified in the literature from 1987 to 1996 were also identified in the literature from 1950 to 1986; however, the labels of the settings are different between the two time periods. Second, the most frequently cited research setting for both time periods was the general hospital (rehabilitation and critical care units); (see Table 3).

In contrast to the findings on research settings, there were two main differences observed in the clinical populations identified in Staum's (1988) literature review and the current literature review. First, the use of music in the physical rehabilitation of individuals with cerebral palsy was cited 38 times between the years of 1950 and 1986 (Staum, 1988), but it was cited only four times in the last 10 years for the rehabilitation of neuromuscular coordination (Holliday, 1987), and the facilitation of muscular relaxation (Pollack, 1988; Skille, 1989; Kline, 1993). Second, the three main populations cited in the literature from 1987 to 1996 were individuals with Cerebrovascular accidents (CVA), traumatic brain injury (TBI), and respiratory disorders (See Table 4). In the years from 1950 to 1986 these same populations received minimal attention. The use of music for the physical rehabilitation of individuals suffering from CVA was cited eight times, individuals with brain injuries were cited six times, and individuals with pulmonary dysfunction were cited five times (Staum, 1988); (see Table 4)

The three populations which benefited the most from music in the last 10 years, were CVA, TBI, and developmental disabilities. The CVA population experienced benefits from music therapy in the areas of neuromuscular coordination, neuromuscular control, and muscular endurance. The TBI population experienced benefits in the areas of neuromuscular coordination, compliance, muscular endurance, and muscular stimulation. The developmental disabilities population experienced benefits in one area, that of compliance, which aided in rehabilitative objectives such as neuromuscular coordination and control.

Table 4 Frequency of Research Setting

Setting	Experimental	Single Subject	Case Report	Total
Hospital (Rehab. Unit, Intensive Care)	8	5	4	17
Research Center	8	0	4	12
Private Home	6	1	0	7
University	6	0	1	7
Public Schools	2	3	0	5
Residential Facility	0	5	0	5
Comprehensive Rehabilitation Center	0	3	0	3
Nursing Home	2	0	0	2
Day Treatment	1	0	0	1

Table 5 Frequency of Clinical Populations

Clinical Population	Experimental	Single Subject	Case Report	Total
CVA	8	2	1	11
TBI (Alert & Comatose)	6	4	1	11
Pulmonary Dysfunction	6	1	1	8
Developmental Disabilities	0	7	0	7
Healthy College Students	5	0	0	5
Cerebral Palsy	2	2	0	4
Healthy Elderly	4	0	0	4
Parkinson's Disease	4	0	0	4
Spinal Cord Injury	1	2	1	4
Arthritis (Rheumatoid & Osteo)	1	1	1	3
Muscle Spasticity	0	0	3	3
Normal Gait	2	0	0	2
Aneurysm	1	0	0	1
Cerebellar Dysfunction	1	0	0	1
Learning Disabled	1	0	0	1
Orthopedic	0	1	0	1
Rett's Syndrome	0	0	1	1
Transverse Myelitis	1	0	0	1

More than one population may be represented in a single study.

Research on healthy individuals (college students, adults ages 25-40, and the elderly) were included in this study to offer possible therapeutic hypotheses for disabled populations. The effect of music on the physical capabilities of healthy populations was not addressed by Staum (1988) in her literature review. The four studies conducted on music's physical effects on college students yielded results indicating significant increases in lower extremity (walking) endurance (Beckett, 1990; Copeland, 1991), and significant increases in upper extremity strength and coordination (Papa, 1988; Thaut et al, 1992). Rathbun (1995) found that fine motor reaction time of healthy college students and healthy elderly improved significantly more when accompanied by rhythmic music compared with rhythmic metronome clicking only. In addition, results from Mezza's (1994) study indicated that rhythmic auditory stimulation (metronome only) does establish an entrainment effect on the gait of healthy elderly subjects.

MusicalApplications

Passive music listening and active music listening (music listening paired with physical activity) were the most frequently used music applications in the years from 1987 to 1996; (see Table 5). Research was conducted on the use of passive music listening with respiratory rehabilitation, muscular relaxation, and muscular stimulation. Research was conducted on the use of active music listening with compliance with treatment and muscular endurance.

The most effective form of active music listening documented in the last 10 years was contingent music. The main type of contingent music was automated feedback, in which electronic devices triggered by the subject's targeted behavior would elicit music (Kearney & Fussey, 1991; Silliman, 1992; Silliman 1993; Sullivan 1994).

Table 5 Frequency of Music Application

Music Application	Experimental	Single Subject	Case Report	Total
Music Listening	11	10	2	23
Movement to Music	12	4	0	16
Auditory Feedback	10	0	1	11
Music Vibration	2	1	4	7
Instrument Playing	2	2	1	5
Singing	0	0	1	1

More than one music application may be researched per study.

Examples included triggers around the chest for upper body posture and on the head for correct head positioning as well as use of multiple automated feedback devices to aid a developmentally delayed, and blind ten year old in gait, upper body posture, and balance (Burch et al, 1987; Kearney & Fussey, 1991; Silliman, 1992; Sullivan, 1994). Apkarian (1991) used the conversion of muscular activity into sound to encourage fine motor exercises.

Movement to music was the second most frequently used music application for both time periods. The main function for which movement to music was used, in both time periods, was neuromuscular coordination. Staum (1988) stated that no rationale was given for the observed beneficial effects of movement to music on neuromuscular coordination. However, she proposed the following: "... the use of music to accompany movement in motor dysfunctional persons provides timing, melodic continuity, and qualitative features effective in coordinating movement patterns" (p. 73). In support of Staum's hypothesis, there were several studies in the last 10 years which observed actual changes in muscular activity, such as improved symmetry, timing, and decreased muscular variability in both upper and lower extremities (Holliday, 1987; Holdren, 1991, Thaut, 1992; Thaut et al 1992a; Thaut et al 1992b; Thaut et al 1993; Thaut et al 1994; Rathbun, 1995; Enzensberger & Fisher, 1996; Hurt, 1996; Miller et al 1996; and Thaut et al 1996).

Movement to music was also effective in muscular endurance and compliance (Johnson, 1989, Thurmond, 1990). Both researchers used client preferred music, and attributed the success of this music application to its pleasing qualities. According to Johnson (1989), the pleasing quality of the music aided in distracting the subjects, as well as improving their attitude towards the therapeutic exercises.

Two music applications were exclusive to the literature documented from 1950 to 1986. Conducting was used effectively in the facilitation of muscular strength (Weigl, 1954 in Staum, 1988). Mark Rider (1985 in Staum, 1988) cited the effective use of the Isoprinciple (the modulation from "tense" to more "relaxed" music) to reduce muscular tension in SCI subjects.

The most drastic contrast in the use of music applications between Staum's (1988) article and this study was the use of instrument playing in physical rehabilitation. Instrument playing was the most frequently used music application from 1950 to 1986 with 50 occurrences. According to Staum (1988), instrumental playing was used effectively in the facilitation of neuromuscular coordination, and muscular strength.

Between the years of 1987 and 1996 instrument playing was cited only six times (Burch et al, 1987, Griggs-Drane, 1989, Johnson, 1989, Oldfield, 1990, Apkarian, 1991, Lucia, 1993). However, despite the scarce documentation of this music application, its use was varied and effective.

Burch et al (1987) and Apkarian (1991) used instrument playing in different ways as a contingency for desired behavior. Burch et al (1987) used a switch that would turn on the sound of a keyboard upon compliance of correct upper body posture, and Apkarian (1991) used a MIDI to transduce muscular activity to keyboard sound, to motivate fine motor exercise. Other instances included the use of percussion instrument playing for upper extremity therapeutic exercise and wind instrument playing for respiratory rehabilitation (Johnson, 1989, Griggs-Drane, 1989, Lucia, 1993).

Research Trends

There were three types of research documented in the literature from 1987 to 1996; case reports, experiments, and single-subject designs. According to Staum (1988), the purpose of case reports is to bring attention to possibly effective therapeutic strategies through the presentation of anecdotal evidence. The purpose of both experimental and single subject designs is to objectively measure the effectiveness of therapeutic strategies through design and data analysis; however the techniques of these two types of research are different. The experimental design is used to discover an isolated cause and effect relation between the independent variable, which is manipulated by the researcher, and the dependent variable, which is measured by the researcher, in a controlled environment (Cozby, 1997). It is necessary to have a control group which does not receive the independent variable and an experimental group which does receive the independent variable to allow for comparisons to be made and the consequent interpretation of results (Cozby, 1997). The focus of this type of research is on group results that may be generalized to a larger population (Cozby, 1997). The single-subject design is used to discover an individual's response to a particular change over a period of time in a particular setting (Cozby, 1997). It is similar to the experimental design in its use of an independent variable and dependent variable. However, instead of using a control group for the interpretation of data the researcher takes baseline data at least at the beginning of the study, in which the subject does not receive the independent variable(Cozby, 1997).

According to Staum (1988), 85% of studies documented from 1950 to 1986 were case reports and 15% were experimental studies. Over the past 10 years, the percentage of case reports has decreased to 11%, with 89% of studies falling into the categories of experimental and single-subject designs. This indicates that emphasis is now being placed on objectively measuring and documenting the effects of music in physical rehabilitation. Furthermore, 88% of experimental studies included a control group in their investigations, which indicates that emphasis is being placed on the accurate interpretation of results. Table 6 is an overview of the dependent and independent variables, measuring techniques, statistical designs, and results of all experimental studies and single-subject studies found in the years from 1987 to 1996.

Another trend in research is seen by the increasing interest in the effects of music in physical rehabilitation by medical and allied health professionals. Analysis of the current literature indicates that 62% of documented studies in this area were published in medical and allied health journals and proceedings, with the remaining 26% of studies published in music therapy sources (See Table 7). According to Staum's data on literature sources, 63% of documented studies from 1950 to 1986 were published in music therapy sources and 37% were published in medical and allied health journals. This change in the literature sources indicates an increase in the research of music in physical rehabilitation by other health professionals outside of music therapy. Furthermore, 23% of the studies found in the literature from 1987 to 1996 involved the collaboration of music therapists and allied health professionals. The increase in the research of music in physical rehabilitation by other health professionals, as well as the collaboration of music therapists with allied health professionals indicates that music therapy is becoming more accepted as a viable therapeutic tool in physical rehabilitation.

Table 6 Index to Clinical Population

Clinical Population	Reference Numbers
Aneurysm	8
Asthma	32, 37
Cerebellar Dysfunction	27
Cerebral Palsy	2,5,12,30
Cerebrovascular Accident (CVA)	6,8,10,19,23,27,29,34,35,47
Chronic Obstructive Pulmonary Disease (COPD, COAD)	7,21,44
Developmental Delay	1,2,11,14,24,33,41,42
Healthy College Students	4,13,18,25,43
Healthy Elderly	38,41,43,45
Infant Respiratory Distress Syndrome	3,31
LearningDisabled	17
Normal Gait	26,27
Orthopedic	19
Osteoarthritis	16,22
Parkinson's Disease	40,46,51,52
Spinal Cord Injury (SCI)	2,39
Transverse Myelitis	27
Traumatic Brain Injury (TBI)	6,8,9,10,15,20,28,36,48,49,50

Table 7 Frequency of Research Site

Research Site	Experimental	Single Subject	Case Report	Total
Clinical	17	13	4	34
Lab	19	2	5	26

Table 8 Experimental & Single-Subject Studies

Author	Year	Source	Rehab. Location	Treatment Time	Patient Diagnosis	Age	Male/Female	N
1 Burch et al	1987	Journal	Residential Facility	10 minutes/17 sessions	Moderate MR; Blind; Non-Ambulatory	31	Male	1
2 Holliday	1987	Thesis	School	5 minutes/ 19-34 sessions	Cerebral Palsy; Spinal Cord Injury; Developmental Delay	4-8 yr.	3 Male/ 5 Female	8
3 Rose	1987	Thesis	Hospital/Neonatal Intensive Care	2 hours	Pre-term infant Respiratory Distress Syndrome	Ave.=32.6 weeks	N/A	10
4 Papa	1988	Thesis	University	N/A	Healthy College Athletes	"College Age"	17 Male/16 Female	33
5 Pollack	1988	Thesis	School	15 minutes/ 8 sessions	Cerebral Palsy	5-13 yrs.	2 Male/ 6 Female	8

Dependent Variable	Measuring Technique	Independent Variable	Auditory Stimulus	Design	Statistics	Results	Follow-Up
1 % of Correct Posture	% of time in correct posture	Keyboard Practice; TV game show; verbal instruction	Facilitation of Compliance	Single Subj.	Visual Analysis	Keyboard Practice- client achieved correct posture an ave. of 49% above baseline; Game show- an ave. of 52% above baseline	N/A
2 Change in Velocity; Speed of Cadence; Height of Step; Time Balancing; Time in Correct Posture; Speed of Crawling	Time to walk 15 feet; Time per step; Frequency of correct step height; Obs. of time in correct posture; Time to crawl to target area	1. Music; No Music 2. Contingent Music; No Music 3. Music as a Reward; No Music	Facilitation of Neuromuscular Coordination; Facilitation of Compliance w/ Physical Therapy	Time Series; Single Subj.	Visual analysis converted in %	Definite increases were observed in all dependent variables.	N/A
3 Heart Rate; Respiratory Rate; Arousal State;TCPO2	Heart Rate; Respiratory Rate; Amt. of TCPO2; Arousal State	Music; No Music	Facilitation of Respiratory Function	Single Subj.	ANCOVA ($p= 0.05$)	NS for Heart Rate or Respiratory Rate; NS for TCPO2;Sign. decrease in arousal state (preferred)	N/A
4 UE strength & endurance	No. & strength of dynamo-meter repetitions	Sedative Music; Stimulative Music; No Music	Facilitation of Muscular Stimulation	Within Subjs. Design	ANOVA ($p< 0.05$) Scheffe's Multiple Comparisons Test ($p< .01$)	Sig. Diff. in muscular strength for stimulative music;NS for muscular endurance	N/A
5 Degree of posture and arm ROM	Video analysis comparison of obs. resting posture at pre&post test; Comparison of obs. arm ROM at pre&post test measured in inches	Stimulative Music; Sedative Music; No Music	Facilitation of Muscle Relaxation	Single Subj.	Mann-Whitney U Test	NS for stimulative vs. sedative music;Responses to music varied b/w individuals & within individuals across time;3 subjs. experienced a reduction in muscle tone w/ music; 2 subjs. increased arm ROM w/ music; 6 subjs. decreased arm ROM w/ music	N/A

Author	Year	Source	Rehab. Location	Treatment Time	Patient Diagnosis	Age	Male/Female	N
6 Basaglia et al	1989	Journal	Rehabilitation Center	40 minutes/ 13 sessions	Genu-recurvatum	N/A	N/A	18
7 Griggs-Drane	1989	Thesis	Hospital	45 minutes/ 6 sessions	COPD	54-78 Ave=70	N/A	16
8 Grundy	1989	Thesis	Rehabilitation Center	60 minutes	TBI; CVA; Aneurysm	13-77	6 Male/ 2 Female	6
9 Grundy	1989	Thesis	Rehabilitation Center	N/A	TBI(Comatose)	53	Male	1
10 Johnson	1989	Thesis	Hospital	N/A	SCI; Right CVA; TBI; Right CVA	22;85;21;79	Female;Female; Female; Male	4
11 Strawbridge et al	1989	Journal	School	17 minutes/ 108 sessions	Profound Mental Retardation	9	Male	1

Dependent Variable	Measuring Technique	Independent Variable	Auditory Stimulus	Design	Statistics	Results	Follow-Up
6 % of Recurvatum	% of recurvatum	Auditory Feedback; No Auditory Feed - back; Walking at Preferred Speed; Walking at Fastest Speed	Facilitation of Neuromuscular Control	Within Subjs. Design	Wilcoxon Test for Paired Data ($p < 0.01$)	Sig. Diff. in % of recur- vatum for both speeds in music cond.	N/A
7 FEV1; FVC; Physical Endur- ance; Treatment Compliance; Concentration	Pulmonary Function Test; Daily Journal; Endurance Test; Prescribed Treatment Eval.	P-Flex Inspiratory Muscle Training; Wind Instruments	Facilitation of Respiratory Function	Matched Pre- Post Control Grp; Post Test Only Control Grp.	Descriptive Research	No observed change in pulmonary function; Increase in physical endurance obs. in both grps; Experimental Grp displayed greater compli- ance than control; No obs. diff. in concentration	Sig. Diff. for both speeds at 15 days, 30 days, 3 mos. &1yr. post- treatment
8 Muscle Tone	EMG recordings	Music; Somatron (music & vibration); Type of Music (new age or classical)	Facilitation of Muscle Relaxation	Within Subjs. Design	Visual Analysis	NS in muscular relaxation	N/A
9 Muscular response; obs. reflexive & voluntary movements	EMG recordings & No. of movements observed	Preferred music; Somatron (Preferred music w/ vibration)	Facilitation of Muscular stimulation	Single Subj.	Visual Analysis	Music and Somatron appeared "slightly effective" in eliciting increases in movement	N/A
10 Muscular Endurance	Observed No. of repetitions	Subj. 1-3: Live Music; No Music Subj. 4:Instrument Playing; No Instrument Playing	Facilitation of Muscular Endurance	Single Subj.	Visual Analysis; Mann-Whitney U Test ($p<0.05$)	Sig. Increase in exercise repetitions across all music conditions w/ all subjects	N/A
11 % of time cor - rectly grasping walker; No. of independent steps taken	Interval obser - vation of correct grasping tech - nique; Frequency recording of independent steps taken	Contingent Music; No Music	Facilitation of Compliance	Single Subj.	Visual Analysis	Increase in compliance of 74.5% over baseline; Increase in No. of independent steps from 1.75 to 65.9.	Compliance was maintained at 4-6 wks.post- treatment w/ con- tingent music at 11 wks.-1 yr. w/ no music

Author	Year	Source	Rehab. Location	Treatment Time	Patient Diagnosis	Age	Male/ Female	N
12 Skille	1989	Journal	Research Center	N/A	Cerebral Palsy	N/A	N/A	N/A
13 Beckett	1990	Journal	University	30 minutes	Healthy	18-22	16 Male/ 16 Female	32
14 Oldfield	1990	Journal	Residential Facility	30 minutes / 40 sessions	Profound Mental Retardation	N/A	N/A	1
15 Sisson	1990	Journal	Hospital	5 minutes	Closed Head Injury (Comatose)	15-29 Ave.= 20.6	3 Male/ 2 Female	5
16 Thurmond	1990	Thesis	Home Treatment	Everyday for 5 mos.; no amt of time noted	Osteoarthritis	51,60,75	All Females	3
17 Weihrach	1990	Dissert.	School	N/A	Learning Disabled	9-11	Male	61

Dependent Variable	Measuring Technique	Independent Variable	Auditory Stimulus	Design	Statistics	Results	Follow-up
12 Presence of hypertonicity	Measuring obs. degree of change in Range of Motion	Vibroacoustic Therapy (Music w/ low frequencies: 40-44 Hz); Music only	Facilitation of Muscle Relaxation	Pre-Post Test Within Subjs.	N/A	Sig. Decrease in hypertonicity in low fequency cond. over music cond.	N/A
13 Distance traveled	Data via Pedometer	Continuous music;Intermittent music; No Music	Facilitation of Muscular Endurance	Within Subjs. Design	t-test ($p< 0.05$)	Sig. Diff. in distance traveled for both music conditions over control; NS b/w music conditions; NS for gender	N/A
14 Time in purpose-ful movement; Correct head posture; Relax-ation of arm muscle	Interval recording of observed data	MusicTherapy (MT); Play Therapy(PT)	Facilitation of Compliance, Neuromuscular Control, & Muscular Relaxation	Single Subj.	Mann-Whitney U Test ($p< 0.05$)	Arm was relaxed significantly longer in MT sessions than Play Therapy sessions for Subj. B, & there was an increase of time in correct head posture in MT sessions over Play Therapy sessions for Subj. B.	N/A
15 Brain activity, behavioral responses	EEG recordings; Frequency recording of observed responses	Music; No Music	Facilitation of Muscle Stimulation	Within Subjects Design	N/A	Obs. changes in EEG activity for subjs. 2 & 3; Obs. changes in behavior for subjs. 1,4,5 (eye opening , head & upper body movement)	N/A
16 Compliance with prescribed exercises	Data collection forms(recorded by subjects); Program questionnaire	Preferred Music (via tape recorder); No Music	Facilitation of Compliance	Multiple Baseline Single Subj.	Cox and Stuart Sign Tests	2 subjs. experienced upward trends in compliance or main - tained prescribed compliance; 1 subject experienced a down - ward trend for one exercise grp & maintained prescribed compliance for remaining grps	N/A
17 Motor Coordination	Scores on 6 dynamic praxis tasks	Metronome; No Metronome; Normal Functioning Subj.; Learning Disabled; Learning Disabled / Motor Challenged	Facilitation of Neuromuscular Coordination	Pre-Post Control Group Design	ANOVA ($p<.0.05$) Scheffe's Multiple Compari-sons Test ($p< 0.10$)	NS	N/A

Author	Year	Source	Rehab. Location	Treatment Time	Patient Diagnosis	Age	Male/ Female	N
18 Copeland et al	1991	Journal	University	15 minutes	Healthy	"College Age"	11 Male/ 13 Female	24
19 Holdren	1991	Thesis	Hospital	60 minutes / 20 sessions	Orthopedic; CVA; Other medical	Female; Ave=77 Male; Ave=75	3 Male/ 22 Female	25
20 Kearney & Fussey	1991	Journal	Hospital	10-15 minutes	TBI	22	Male	1
21 Sidani	1991	Thesis	Hospital	20 minutes	COAD	58-77	2 Male/ 8 Female	10
22 Bernard	1992	Journal	Residential Facility	N/A	Osteoarthritis	65-99 Ave=85	Female	25

Dependent Variable	Measuring Technique	Independent Variable	Auditory Stimulus	Design	Statistics	Results	Follow- Up
18 Heart Rate; Time to exhaustion; Perceived Exertion	Obs. Time to exhaustion; Electrocardio-gram data; Borg's 10pt RPE Scale	"High Intensity" Music (75-85 db) & M.M. of 140; "Low Intensity" Music (60-70 db) & M.M. of 100; No Music	Facilitation of Muscular Endurance	Within Subjs.	ANOVA; Newman-Kauls Post Hoc Analysis ($p < 0.10$)	Sig. Diff. in time to exhaustion for "Low Intensity" Music; Sig. Diff. in rating of perceived exertion for "Low Intensity" Music	N/A
19 Independent Move-ment in standing, sitting, walking (agility); Pace (vel-ocity & quality)	Ratings on behavioral indices on a Lickert Scale	Music; No Music	Facilitation of Neuromuscular Coordination	Simple Inter-rupted Time Series Design	Descriptive	Agility improved in 8 subjs. after the music cond.; 13 subjs.increased their pace during the music cond.; 16 subjs. increased their quality of movement during the music cond.	N/A
20 Posture	No. of times correct posture was attained	Contingent Music; No Music	Facilitation of Compliance	Single Subj.	Auto-correlation linear regres-sion; t-test ($p < 0.01$)	Sig. increase of correct head posture in music condition	Increase in correct posture was main - tained at 4 wks post-treatment
21 Perception of dyspnea; Respiratory Rate; O2 Saturation; Heart Rate	Dyspnea Rating Scale; PulseOximeter; Observed Respiratory Rate	"Sedative" Music; No Music	Facilitation of Respiratory Function	Within Subjs. Design	t-test ($p < 0.05$)	NS in dyspnea rating; Sig. Diff. in respiratory rate for music condition; NS in O2 saturation	N/A
22 No. of exercise repetitions (upper extremity)	No. of observed exercise repetitions	Music; No Music	Facilitation of Compliance	Within Subjs. Design	Mann-Whitney U Test; Wilcoxon Matched Pairs Signed Ranks Test ($p < 0.05$)	NS	N/A

Author	Year	Source	Rehab. Location	Treatment Time	Patient Diagnosis	Age	Male/ Female	N
23 Morris	1992	Journal	Hospital	45 minutes / 20 sessions	Stroke (Genu-Recurvatum)	33-74 Ave=64	12 Male/ 14 Female	26
24 Silliman et al	1992	Journal	Residential Facility	30 minutes/ 20 sessions	Profoundly Mentally Retarded	10	Male	1
25 Thaut et al	1992a	Proceedings	University Lab	N/A	Healthy Music Students	19-32 yrs.	All Females	24
26 Thaut et al	1992b	Journal	Research Center	N/A	Normal Functioning Gait	25-40	6 Male/ 10 Female	16
27 Thaut et al	1992c	Journal	Research Center	N/A	Stroke; Cerebellar Dysfunction; Transverse Myelitis; Healthy	Stroke (65,70) Cerebellar (44) Transverse Myelitis (24) Healthy (25-40)	6 Male/ 6 Female	12

Dependent Variable	Measuring Technique	Independent Variable	Auditory Stimulus	Design	Statistics	Results	Follow-Up
23 KneeHyper-extension Error; Gait Recovery; Velocity; Temporal Asymmetry	Electrogonio-meter; Motor Assesment Scale; Clinical StrideAnalyzer	Physical Therapy Only;Physical Therapy & Electro-goniometric Feed - back(Auditory)	Facilitation of Neuromuscular Control	Pre-Post Test Control Grp. Design	Mann-Whitney U Test; Wilcoxon Signed Ranks Test	Sig. Decrease in knee hyperextension in auditory feedback cond.; NS for Velocity; NS for Temporal Asymmetry	N/A
24 Walking Distance; Steps Climbed; Standing Height; Correct Sitting Posture	Frequency recording	Contingent Music; No Music	Facilitation of Neuromuscular Coordination	Multiple Baseline Single Subj.	Visual Analysis	Contingent music was observed to be effective across all 4 dependent variables	Generalization of learned skills were maintained at 2 wk follow-up; Decrease in same areas at 3 mo. follow-up
25 Duration of triceps & biceps muscle activation before & after target contact; Variation of muscle activity	Recorded EMG data	Rhythmic Auditory Stimulation matched to cadence & slower than cadence (via metro-nome click); No Rhythmic Auditory Stimulation	Facilitation of Muscular Stimulation	Control Grp Design	Visual Analysis; 1-way ANOVA; 2-way ANOVA; Scheffe post hoc analysis	Sig. increase in the duration of triceps activity before target contact for both rhythmic conds.; Sig. increase in duration of biceps activity after target contact in slower rhythmic cond.; Sig. increase in length of co-contraction for both rhythmic conds.	N/A
26 Temporal stride symmetry & consistency; EMG variability	Data from computerized foot-switches, EMG, & Video Analysis	Rhythmic Auditory Stimulation; No Auditory Stimu-lation; Preferred tempo	Facilitation of Neuromuscular Coordination	Within Subjs Design	MANOVA ($p < 0.05$)	Sig. Difference in stride symmetry & EMG varia-bility in stride initiation & gastrocnemius activity for rhythmic auditory stimulation	N/A
27 Gastrocnemius activity; timing of stride cycle; kinematics	Data via EMG; pressure sensitive walk way; video recorder	Rhythmic Auditory Stimulation; No Music	Facilitation of Neuromuscular Coordination	Within Subjs. Design	ANOVA ($p < 0.05$)	Sig. Diff. in EMG duration, variation, & ampli tude of gastrocnemius in normal & abnormal gait patterns in music cond.; Sig. Diff. in stride cycle for abnormal gait patterns in music cond.	N/A

Author	Year	Source	Rehab. Location	Treatment Time	Patient Diagnosis	Age	Male/ Female	N
28 Wilson et al	1992	Journal	Hospital; Long-term nursing facility	30 minutes/ 15 sessions	Comatose (Closed Head Injuries)	15,18,20,29	Male	4
29 Engardt et al	1993	Journal	Rehabilitation Center	15 minutes/ 90 sessions	CVA	Ave=65	25 Male/ 15 Female	40
30 Kline	1993	Thesis	Day Treatment Facility	20 minutes / 4 sessions	Cerebral Palsy	5-15 (Ave=10)	6 Male/ 6 Female	12
31 Loggers	1993	Book	Neonatal Intensive Care	90 minutes	Infant Respiratory Distress Syndrome	Less than 35 wks.	N/A	15

Dependent Variable	Measuring Technique	Independent Variable	Auditory Stimulus	Design	Statistics	Results	Follow-Up
28 Change in observable behavior	# of observed behavioral changes	Music; No music	Facilitation of Muscular Stimulation	Within Subjs. Design	t-test ($p < 0.025$)	Sig. Diff. in occurrence of eye-opening & body movement b/w pre-test & music cond. and b/w pre and post tests for 2 subjs(15,29); Sig. Diff. in occurrence of eye-opening b/w music condition & post-test for 20 yr. old; NS for 18 yr old	N/A
29 Motor and Postural Functioning; Self-care and Mobility	Motor Assesment Scale; Fugl Mayer Assesment; Barthel Index (self-care and mobility)	Auditory Feedback; No Auditory Feedback	Facilitation of Neuromuscular Control	Pre-test, Post-test Control Grp Design	Student's paired & unpaired t-tests ($p < 0.01$); Wilcoxon Signed & Ranked Test; Mann-Whitney U Test ($p < 0.05$) Spearman Rank Correlation ($p < 0.01$)	Sig. Diff. in Body Weight Dist. upon rising for auditory feedback cond.; Sig. Diff. in Body Weight Dist. upon sitting for auditory feedback cond.; Sig. Diff. in Self-Care & Mobility for auditory feedback cond.; Sig. Correlation b/w Weight Dist. & Self-Care/Mobility	N/A
30 Degree of elbow range of motion	Goniometric Data	No Music; Neutral Warmth only; Music only; Neutral Warmth & Music	Facilitation of Muscular Relaxation	Pre-Post Within Subjs Design	MANOVA ($p < 0.05$)	Sig. Diff. in elbow extension for music, neutral warmth, and music & neutral warmth	N/A
31 Respiration Pattern; Heart Rate; PaO2	N/A	Music; No Music	Facilitation of Respiratory Function	Within Subjs.	N/A	NS for all dependent variables	N/A

Author	Year	Source	Rehab. Location	Treatment Time	Diagnosis	Age	Male/Female	N
32 Lucia	1993	Dissertation	School	28 days	Asthma	Youth	N/A	18
33 Silliman	1993	Dissertation	Residential Facility	90 minutes / 45 sessions	Profoundly Mentally Retarded	25-34	3 Male/ 4 Female	7
34 Thaut	1993	Journal	Research Center	3 sessions	CVA	49-87 (Ave=70)	8 Male/ 2 Female	10
35 Engardt	1994	Journal	University	Follow-Up	CVA	Ave=66	16 Male/14 Female	30

Dependent Variable	Measuring Technique	Independent Variable	Auditory Stimulus	Design	Statistics	Results	Follow-Up
32 Frequency of Asthma symptoms; Change in attitude; fatigue	Frequency of symptoms recorded through self-report measures	Playing wind instrument; Not playing wind instrument; Diagnosis of Mild, Moderate, Severe	Facilitation of Respiratory Function	Control Grp Design	ANOVA ($p < 0.05$)	Sig. Diff. in asthma symptoms & quality of life for Exp. Subj.; Sig. Diff. in severity of symptoms b/w Exp. subj. & control subj. (moderate & severe asthmatics only);Sig. Diff. in attitude change & iritability for Exp. subj; NS for fatigue	N/A
33 Frequency of ambulation w/ correct posture	Time recorded on feedback device; Scores of the StokerWalking Profile	Preferred Music; Aversive Tone; No Music; 3 leves of Criteria	Facilitation of Compliance	Single Subj Design	Friedman 2Way ANOVA ($p < 0.05$)	Sig. Diff. in % of ambulation w/ correct posture for music cond. across subjects	Carry-over effect of correct posture for all subjs. at 2 days post-treatment; Carry-over effect for Subjs. 6 &7 at 2,4, & 12 wks post-treatment
34 Temporal stride symmetry & consistency; magnitude & variability of EMG activity	Electric foot-switch sensors & EMG Data	Rhythmic auditory stimulation(movement to music); No music	Facilitation of Neuromuscular Coordination	Within Subjects Design	MANOVA ($p=0.05$)	Sig. increase in weight-bearing stance time on paretic leg, stride rhythmicity, & muscle activation on paretic side; Sig. decrease in EMG variability on pareitc side, and EMG activity during swing phase	N/A
35 Weight symmetry b/w paretic & non-paretic leg while sitting &standing; Speed of sitting & standing	Data from strain-guage force transducers	No Auditory Feedback; Auditory Feedback	Facilitation of Neuromuscular Control	Control Grp Design (Follow-up)	Student's t-test ($p < 0.05$); Chi Square	Sig. decrease in symmetry while sitting and standing for Exp. group;Sig. increase in time to completion of task for Exp. group	This was a Follow-Up Study

Author	Year	Source	Rehab. Location	Treatment Time	Patient Diagnosis	Age	Male/ Female	N
36 Jones et al	1994	Journal	Rehabilitation Center	20 minutes / 28 sessions	TBI(comatose)	16	Male	1
37 Lehrer et al	1994	Journal	N/A	8 sessions - w/ 60 minutes/day home practice	Asthma	18-65	53 Male/53 Female	106
38 Mezza	1994	Thesis	Research Center	N/A	Healthy Elderly	Ave=72	3 Male/6 Female	9
39 Phillips et al	1994	Journal	University	10 minutes / 4 sessions	Spinal Cord Injury	28	Male	1
40 Thaut et al	1994	Journal	Research Center	1 session	Parkinson's Disease	Ave=71	N/A	6

Dependent Variable	Measuring Technique	Independent Variable	Auditory Stimulus	Design	Statistics	Results	Follow-Up
36 Presence of voluntary and /or involuntary movement	Frequency recording via Video Camera	Taped Auditory stim.: Voices of Family& Friends; Classical Music; Rock Music; Nature Sounds	Facilitation of Muscle Stimulation	Interrupted Time Series Design	ARIMA (P= 0.05)	Sig. Diff. in body movement for voices of friends & family only	N/A
37 Bronchial hyperactivity to metacholine	Spirometer; Self-Report Logs; Asthma symptom checklist	Progressive Muscle Relaxation;"Relaxing" Music; No Music	Facilitation of Pulmonary Function	Pre-test/ Post-test Control Grp Design	Split-Plot ANOVA (p< 0.05)	Sig. increase in relaxation for Progressive Relaxation over music cond.; Sig. increase in relaxation for music cond. over control; NS for meta-choline challenge, pulmo-nary function, or asthma severity across groups	N/A
38 Presence of entrain-ment; Synchroni-zation Error b/w step & audi- tory stim; Presence of Carry-Over Effect	Data collected via electronic foot switches & computer calculations	Rhythmic Auditory Stim.(Clicks); Preferred Cadence; 25% faster; 25% slower	Facilitation of Neuromuscular Coordination	Within Subjects	t-test & ANOVA (p< 0.05)	Sig.Diff. in entrainment effect; NS for synchroni- zation error; Sig. Diff. in Carry-Over Effect in cadence, symmetry, velocity,& stride length	N/A
39 Velocity	Observation	Auditory Stim: Metronome; Metronome & Knowledge of Stride Length; No Feedback Walking Speed: .064,1.22, 1.8 kph	Facilitation of Neuromuscular Coordination	Within Subjects	ANOVA for repeated measures (P< 0.05)	Sig. Decrease in distance error for Metronome &Metro-nome/ Stride Length Conds. at 1.22 kph; Sig. Increase in distance error for same conds. at 1.80 kph	N/A
40 Velocity; Cadence; Stride Length; Symmetry	EMG; Electric Footswitches; Video Analysis; Data via Computer	Tempo: Normal cadence & Faster Cadence; RAS & No RAS	Facilitation of Neuromuscular Coordination	Within Subjects	N/A	RAS at 10% faster than baseline gait resulted in a sign. improvement in mean gait velocity, cadence, & stride length; 5 of 6 subjs. maintained improvement during faded RAS; Evidence of entrainment effect.	N/A

Author	Year	Source	Rehab. Location	Treatment Time	Patient Diagnosis	Age	Male/ Female	N
41 Brault	1995	Thesis	Research Center	15 minutes / 15 sessions	Healthy Elderly	60-79	12 Male/ 12 Female	24
42 Landrieu-Seiter et al	1995	Journal	Residential Facility	30 sessions/ No time stated	Profound Mental Retardation/ Nonambulatory	10-15	4 Males/ 2 Female	6
43 Rathbun	1995	Thesis	Research Center	30 minutes	Healthy College Students; Healthy Elderly	18-25 over 65	N/A	24
44 Thornby	1995	Journal	Hospital	N/A	COPD	45-75 Ave= 63	11 Male/ 25 Female	36
45 Cilento	1996	Thesis	Residential Facility	3 Minutes	Well-Elderly	69-94	N/A	60

Dependent Variable	Measuring Technique	Independent Variable	Auditory Stimulation	Design	Statistics	Results	Follow-Up
41 Gait velocity; Cadence; Stride length; Stride symmetry; swing/ stance ratio; double support time	Data via Electronic Foot-switches & Computer	Subject preferred Rhythmic Auditory Stim. Tapes; Self-Paced Training; No Training	Facilitation of Neuromuscular Coordination	Control Grp. Design	One-way ANOVA ($p < 0.05$)	NS for all dependent variables	N/A
42 Exercise perfor mance/ Upper extremities	Obs. increase in weights mani-pulated; Obs. No. of exercise repititions	Verbal praise only; Music only; Audio-visual only; Verbal praise & music; Verbal praise & audio-visual	Facilitation of Compliance	Single Subjs.	Visual Analysis/ Split-Middle Technique	Positive trends across time obs. when verbal praise only or verbal praise plus video or music reinforcement were used	Positive trends were maintained during 2 wk follow-up under baseline conds.
43 Positional accuracy; Consistency of motor response	Synchronization error; Variability of Interesponse Intervals;Synchro-nization error Variability via computer	Age group (College, Elderly); Music, Metronome only; Frequency rates (.5,1,2,3,4,5 Hz)	Facilitation of Neuromuscular Coordination	Within Subjs Design	Matched pairs t-test ($p=0.05$); t-test ($p=0.05$)	Sig. Diff. in positional accuracy at1,2,3,4 Hz in music cond.; NS in Inter-response Interval consis-tency; Sig. Diff. in Syn-chronization Error at 1 Hz	N/A
44 Perceived respira-tory effort; Exercise capacity	Borg Rating; Calculations of Obs. Total Exercise Time	Music; No Music; Grey Noise; Walking Speed; % of Incline	Facilitation of Muscular Endurance	Within Subjs. Design	MANOVA ($p < 0.001$)	Sig. Diff. in perceived exertion & exercise tolerance for music cond.	N/A
45 No. of exercise repetitions (upper body)	Obs. No. of exercise repititions	Background Music/ No Music	Facilitation of Muscular Endurance & Strength	Control Grp. Design	t-test ($p=0.05$) Two-way ANCOVA ($p=.05$)	NS for Music vs No Music; NS for effects of Age, Gender, & Music on No. Of Repetitions	N/A

Author	Year	Source	Rehab. Location	Treatment Time	Diagnosis	Age	Male/Female	N
46 Enzenberger & Fischer	1996	Journal	Hospital	N/A	Parkinson's Diesease	N/A	N/A	22
47 Fowler & Carr	1996	Journal	University	3 wk training	CVA	N/A	N/A	12
48 Hurt	1996	Thesis	Research Center	1 session	TBI	25-35	5 Male/3 Female	8
49 Hurt	1996	Thesis	Research Center	6-12 minutes/ day/ 3 wks	TBI	25-35	3 Male/ 2 Female	5
50 Joichi	1996	Symposium	Research Center	N/A	Traumatic Brain Injury	30's	1 Male	1

Dependent Variable	Measuring Technique	Independent Variable	Auditory Stimulation	Design	Statistics	Results	Follow-Up
46 No. of steps; Velocity; No. of freezing episodes	Frequency recording of steps taken & freezing episodes; Obs. time of course completion	Metronome; Trad. March Music; Contemporary March Music; Tactile Stimulation; No Auditory or Tactile Stim.	Facilitation of Neuromuscular Coordination	Within Subjs. Design	N/A	Sig. Diff. in No. of steps taken & velocity for metronome cond.; Reduction of "freezing" from 3 times to 0 on straight way & 12 times to 0 on turns for metronome cond.	N/A
47 Weight Dist. on affected leg; Time to peak vertical force while standing	Data from Limb-load Monitors on each leg & seat switch	Auditory Feedback; No Auditory Feedback	Facilitation of Neuromuscular Control	Control Grp. Design	Student's t-test ($p < 0.05$)	NS for both dependent measures	N/A
48 Cadence; Velocity; Stride Length; Symmetry	Data from electric foot switches; Computer Analysis	Tempo: Normal Cadence & Faster Cadence; RAS & No RAS	Facilitation of Neuromuscular Coordination	Within Subjs.	ANOVA ($p < 0.05$)	NS for all dependent measures	N/A
49 Cadence; Velocity; Stride Length; Symmetry	Data from electronic foot switches; Computer analysis	Tempo: Normal Cadence & Faster Cadence; Time	Facilitation of Neuromuscular Coordination	Within Subjs.	ANOVA ($p < 0.05$)	Sig. Increase in Cadence, Velocity, Stride Length	N/A
50 Interresponse Interval(IRI); Synchronization Error(SE); Difference b/w the stimulus & tapping interval(ISI-IRI)	Data Recorded via Computer	Cue: uncued, white noise, metronome, music; Frequency: 1Hz, 2Hz, .05Hz; Hand: left (paretic), right (nonparetic)	Facilitation of Neuromuscular Coordination	Within Subjs.	N/A	Sig. improvement in timing for music & metronome vs. white noise & uncued conds. at 1Hz & .05Hz; Timing of paretic hand was sign. decreased vs. non-paretic hand for .05Hz only.	N/A

Author	Year	Source	Rehab. Location	Treatment Time	Diagnosis	Age	Male/ Female	N
51 Miller et al	1996	Journal	Research Center	25 minutes/day/3 wks.	Parkinson's Disease	Ave=70	N/A	37
52 Thaut et al	1996	Journal	Research Center	30 minutes/day/ 3 wks.	Parkinson's Disease	Ave=71	10 Male/ 5 Female	15

Dependent Variable	Measuring Technique	Independent Variable	Auditory Stimulus	Design	Statistics	Results	Follow-Up
51 EMG variability (shape &timing) symmetry; Velocity; Stride Length; Swing symmetry	EMG Data & Electronic Foot Switches	Rhythmic Auditory Stim. Training	Facilitation of Neuromuscular Coordination	Pre-Post Control Grp. Design	LCEA-EMG variability; Bonferroni t-test ($p< 0.05$)	Sig. Diff. in EMG variability (shape) for Medial gastroc-nemius & Tibialis Anterior; NS for EMG variability (timing); Sig. Diff. in EMG symmetry for Tibialis Anterior; Sig Diff. in velocity & stride length; NS in swing symmetry	N/A
52 EMG variability, symmetry, timing; Velocity (flat & incline walk ways); Cadence & Stride Length (flat walk way)	EMG Data & Electronic Foot Switches	Rhythmic Auditory Stim. Training; Self-Paced Training; No Training; Flat surface; Incline; Stepping Task	Facilitation of Neuromuscular Coordination	Pre-Post Control Grp. Design	Non-Parametric ANOVA for EMG Analy-sis ($p< 0.05$); ANOVA for Gait parameters ($p< 0.05$)	NS for variability & sym-metry; Sig. Diff. in EMG duration of Tibialis Anterior & Vastus Lateralis; Sig. Diff. in velocity on flat & inclined surfaces of RAS over Self-Paced Training & No Training; Sig. Diff. in Stride Length of RAS vs. No Training; Sig. Diff. in Cadence of RAS vs. Self-Paced Training	N/A

Table 9 Type and Frequency of Sources

Sources	Experimental	Single-Subject	Case Report	Total
Music Therapy				
Master's Theses	5	5	0	10
Journal of Music Therapy	2	0	0	2
Journal of British Music Therapy	0	0	1	1
Internat'l MusicMedicne Symposium: Volume of Abstracts	1	0	0	1
Music Education and Therapy-Book	1	0	0	1
Medical/Nursing				
Annals of Neurology	1	0	0	1
Archives of Physical Medicine and Rehabilitation	2	0	0	2
Master's Theses	3	1	1	5
Scandinavian Journal of Rehabilitation Medicine	2	0	0	2
Brain Injury	0	1	0	1
Chest	1	0	0	1
Electroencephalography and Clinical Neurophysiology	1	0	0	1
Heart and Lung	1	0	0	1
Journal of Behavioral Medicine	1	0	0	1
Journal of the Royal Society of Medicine	0	0	1	1
The Lancet	1	0	0	1
Medical Engineering and Physics	1	0	0	1
Physical/Occupational Therapy				
Master's Theses	4	1	0	5
Clinical Kinesiology	0	1	0	1
Clinical Rehabilitation	0	1	0	1
Dissertation	1	0	0	1
Internat'l Journal of Rehabilitation Research	1	0	0	1
Journal of Neurological Rehabilitation	2	0	0	2
Movement Disorders	1	0	0	1
Physical and Occupational Therapy in Geriatrics	1	0	0	1
Physical Therapy	1	0	0	1
Posture and Gait: Control Mechanisms,1992, 11th Internat'l Symposium of the Society for Postural and Gait Research	1	0	0	1
RESNA Proceedings,1991, of the 14th Annual Conference	0	0	1	1

Developmental Disabilities				
Education and Training in Mental Retardation	0	1	0	1
ERIC Research Document	0	0	1	1
Journal of Mental Deficiency Research	0	1	0	1
Research in Develop-mental Disabilities	0	1	0	1
Sports Science				
Master's Thesis	1	0	0	1
The Journal of Sports Medicine and Physical Fitness	1	0	0	1

CHAPTER 6

Conclusions

A comprehensive literature review and analysis was conducted on the use of music in physical rehabilitation from 1987 to 1996. The purpose of this study was to provide music therapists with an updated and comprehensive resource to aid in choosing effective treatment strategies for client's in need of physical rehabilitation, as well as providing an awareness of populations which have benefited from the use of music in physical rehabilitation.

The majority of sources were found in journals and master's theses. The main bibliographical sources consulted were the electronic data bases of Medline, PsycInfo, FirstSearch (WorldCat & ArticleFirst), and Dissertation Abstracts. The findings were organized according to treatment modalities, clinical settings and populations, musical applications, and research trends.

The three most frequently researched treatment modalities from the years 1987 to 1996 were neuromuscular coordination, compliance, and respiratory rehabilitation. Neuromuscular coordination was also the most frequently researched treatment modality from 1950 to 1986. This indicates a consistent and continuing need for research in music applications for neuromuscular coordination. The frequency of compliance studies indicates the importance that is placed on patient cooperation with the therapeutic process. The increase in research on music in respiratory rehabilitation, indicates an increased interest in music as a therapeutic tool for patients with respiratory disorders, and a couple of studies indicated that music was beneficial (Griggs-Drane, 1989, Zellmer, 1989, Thornby, 1995).

The treatment modality of muscular endurance, which was neglected in the literature from 1950 to 1986 was given greater attention in recent years. Positive results were observed in the use of music for muscular endurance in both lower and upper extremities (Beckett, 1990, Copeland, 1991, Johnson, 1989). Thus further investigation into the use of music for muscular endurance is indicated.

The most frequently cited setting in the literature from 1987 to 1996 remains the general hospital (rehabilitation units and critical care). However, the most frequently cited clinical populations have changed over the past 10 years from cerebral palsy and developmentally disabled populations to cerebrovascular accident and traumatic brain injury populations. This indicates that though there has been a change in interest of populations, the concept of music in physical rehabilitation is of continuing interest and is receiving support from hospital administrations. The analysis of literature from 1987 to 1996 also indicated that the CVA and TBI populations actually benefited the most from the use of music in physical rehabilitation. This gives added support to the continued research on music in the rehabilitation of these two populations.

The two most frequently used musical applications were music listening (passive and active) and movement to music. Both of these musical applications were effective therapeutic tools. Results indicated that contingent music listening (an active form of listening) was the most effective music application in compliance studies with the developmentally disabled population. This suggests that pleasing auditory experiences are important to this population. Results indicated that movement to rhythmic music was used most often and effectively with the neuromuscular coordination of the lower extremities. As was stated previously, the presence of constant and predictable auditory cues seems to organize movement, as evidenced by analysis of Electromyographic data. A few studies have investigated the use of rhythmic music and rhythmic auditory clicks only on the upper extremities, with positive results (Thaut et al, 1992, Rathbun, 1995, Joichi, 1996). Therefore, an increase in research of movement to music and upper extremity coordination is warranted.

Instrument playing, which was the most frequently cited musical application in the years from 1950 to 1986, was one of the least cited music applications from 1987 to 1996. This trend in the research is disturbing, because it indicates a lack of active and creative participation of patients with the musical experience and possibly the therapeutic experience. As stated previously, Kottke and Lehmann (1990) emphasized that vocational capability, personal achievement, and creativity were to be considered as the highest level of human functioning. Instrument playing, as a therapeutic tool would allow patients to experience this highest level of human functioning, while they are working at a lower level of physical functioning.

There was a drastic change in the types of research conducted over the last 10 years, in favor of experimental and single subject designs. Furthermore, 88% of experimental studies included a control group in their investigation. This suggests that emphasis is now being placed on the objective measurement of the effect that specific musical applications have for specific rehabilitative needs, as well as the accurate interpretation of results.

Analysis of the current literature also indicates that the majority of sources documented from 1987 to 1996 were published in medical and allied health journals, thus indicating an increase in the interest of music as an effective therapeutic tool in physical rehabilitation by health professionals other than music therapists. Furthermore, 23% of all studies (case reports, experiments, and single-subjects) were a collaborative effort of music therapists and allied health professionals. This is positive news to the music therapy population, and will hopefully encourage music therapists to increase their own research in the use of music in physical rehabilitation.

Four studies may be particularly helpful to music therapists in the development of further research in music for physical rehabilitation; two experimental studies by Thaut et al (1992, 1993), one single subject by Holliday (1987), and one case report by Zellmer (1989). All four studies gave evidence of a knowledge of the population of interest and a knowledge of the use of music with that population. Each study also stated a definite purpose and rationale and defined the independent and dependent variables.

The study entitled Effect of Rhythmic Auditory Cueing on Temporal Stride Parameters and EMG Patterns in Normal Gait (Thaut et al, 1992) is an example the benefits of collaborating with allied health professionals, and the benefits of investigating the effects of music on healthy subjects. The study was a result of the collaboration of Thaut (a music therapist), a neurologist, a physical therapist, and a bio-mechanist.

Results from the study indicated significant improvement in stride rhythmicity and effected muscle activity of the gastrocnemius with rhythmic auditory cueing during locomotion. In the article Effect of Rhythmic Auditory Cueing on Temporal Stride Parameters and EMG Patterns in Hemiparetic Gait of Stroke Patients (Thaut et al, 1993), the same group of professionals applied the information learned from the use of rhythmic auditory cueing on normal gait to the gait patterns of stroke patients. Results indicated significant improvements in the stride parameters and effected muscle activity in the stroke patients with the use of rhythmic auditory cueing. These two controlled studies formed a solid foundation for further research that indicated significant gait improvements resulted from the use of Rhythmic Auditory Stimulation (RAS) with individuals suffering from Parkinson's Disease and Traumatic Brain Injury (TBI) (Thaut et al, 1994; Miller et al, 1996; Thaut et al, 1996; Hurt, 1996).

The single-subject study entitled Music Therapy and Physical Therapy to Habilitate Physical Disabilities of Young Children (Holliday, 1987), is an example of the therapeutic benefits of the single-subject design. Through collaboration with the subject's physical therapist and classroom teacher, Holliday devised specific objectives with specific criteria for each individual, and then chose music applications to facilitate those objectives. Holliday (1987) took a baseline period at the beginning at least for each study which made comparisons possible. Results indicated that each objective was reached for eachindividual.

Zellmer's (1989) case report entitled, Response of a Premature Infant with Bronchopulmonary Dysplasia to Music Therapy: A Nursing Protocol demonstrated the benefits of the judicious use of music therapy as an integral part of a premature infant's treatment. Zellmer (1989) identified the needs of her patient (increased relaxation and sleep, increased stimulation, etc.) and chose music appropriate for the age of the patient, continually monitoring the physiological effects and emotional responses to the music. As a result, a successful protocol was developed in which music listening induced relaxation, increased sleep, decreased the need for supplemental oxygen, increased oxygen saturation, and stabilized the respiratory rate of the infant. Music was further used to facilitate socialization and increase stimulation.

As observed from these four studies and others that were discussed in this literature review, music has been successfully used to facilitate physical rehabilitation when appropriate knowledge of the population is combined with the knowledgeable use of music. This literature review and analysis of the use of music in physical rehabilitation from 1987 to 1996 may be used as an effective resource for the effective treatment of individuals in need of physical rehabilitation by providing an overview of the treatment modalities with which music was used, the clinical implications from a comparison with Staum's (1988) literature review, an extensive table that outlines all experimental and single-subject studies, conclusions, and by extending the knowledge of the literature from 1987 to 1996.

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