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THE EFFECT OF MUSIC LISTENING ON
EXCESSIVE MUSCLE TONE OF SPASTIC
CEREBRAL PALSIED CHILDREN

presented by

Nancy Joan Pollack

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# THE EFFECT OF MUSIC LISTENING ON EXCESSIVE MUSCLE TONE OF SPASTIC CEREBRAL PALSIED CHILDREN

By

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## ABSTRACT

### THE EFFECT OF MUSIC LISTENING ON EXCESSIVE MUSCLE TONE OF SPASTIC CEREBRAL PALSIED CHILDREN

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This study examined the relationship between music listening and excessive muscle tone of spastic cerebral palsied children. Eight subjects, ages 5 to 13, two males and six females, were treated individually in eight 15-minute sessions over a period of four weeks. The experimental treatment was a five-minute taped music listening period, using either stimulative or sedative music, contrasted with a no-music condition in one session. Degree of muscle tone was measured in a pretest-posttest in each session using videotaping of resting posture and performance of an arm motion task. Evaluation of resting postures and task scores indicated a decrease in muscle tone for the group in each session, and showed that the music treatment had a varying effect on individual subjects. No difference was found in the effects of stimulative and sedative music on the muscle tone states of the subjects.

## ACKNOWLEDGMENTS

The author wishes to express sincere appreciation to Professor Robert Unkefer and Dr. Dale Bartlett for their support and guidance throughout this study.

Thanks and acknowledgment are also offered to Sheila Keane and Jann Nestell for their individual help in developing concepts and procedures used in this study, and to Cheryl Swanson, Roger Smeltekop, Dorothy Barr, and Louise Magnus for their help in evaluating music selections. The author wishes to thank and acknowledge the following individuals at North Elementary School and Rich Middle School, whose help and contributions made this study possible.

North School: Dr. Joanne Witte, Assistant Principal; Ginger Fales, Media Specialist; Marge Novak, Leone White, Jeanne Boyd--Physical Therapy; Mimi Scherer, Donna Ethington, Linda MacDonald--Occupational Therapy; Marti Spieth, Speech Therapy; Blanche Bobowski, Gretchen Garmyn, Nancy Wallen, POHI teaching staff; and Mary Adelson, POHI Teacher Consultant.

Rich School: Bev Miller--Physical Therapy; Ruby Frazier--Occupational Therapy; Sue Strysko--POHI Teaching Staff; Barb Esch--Speech Therapy.

A very special thanks is offered to the children who participated in this study, and to their parents for their willing cooperation.

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# CHAPTER I

# THE PROBLEM

## Introduction

Cerebral palsy is a neuromuscular disorder affecting all areas of development. Originating at birth or in childhood, the disorder influences the motor, intellectual, and social-emotional behavior of the growing child. Disturbances in motor function arise from paralysis, weakness, and incoordination caused by damage to the motor centers of the brain. Of the cerebral palsied populations studied, 50 to 75 percent have some degree of mental retardation. There is a high incidence of speech impairment, and perceptual-motor deficits are common.

Treatment begins in early childhood, before motor patterns are established, and takes the form of therapy to increase the level of motor functioning, and to develop adaptations for daily living and educational activities. Because cerebral palsy varies in type, extent, severity, and presence of associated impairments, each cerebral palsied child is unique, and requires an individualized treatment program to insure maximum functioning in the home and school environments. The

following statement of Cruickshank (1966) effectively expresses the difficulties and challenges involved in treating cerebral palsied children:

> Differences in degree of involvement, differences in degree of hearing or visual impairment, differences in severity and type of seizures, differences in extent of speech involvement, differences in level of intellectual capacity, differences in emotional development and behavior, differences in the way in which, as the result of any of the above factors, the child responds to his learning environment--all these contribute to the complexity of the problem. The proportions of the problem become staggering insofar as habilitation and education are concerned when one considers the multiplicity of variables possible in cerebral palsied children (pp. 21-22).

## Purpose of the Study

The purpose of this study is to determine if music listening has an effect on excessive muscle tone in spastic cerebral palsied children. Spasticity, a clinical type of cerebral palsy, is manifested by hypertonicity (tight muscles), hyperactive deep tendon reflexes (involuntary muscular contractions following a direct stimulus), and clonus (muscular spasm). Movement in the spastic is characterized by the exaggerated contraction or shortening of muscles when subjected to stretch. Voluntary movements are often blocked by the simultaneous contraction of opposing muscles. The components of spasticity produce in the spastic child a state of high muscular tension, which may be intensified by the excessive effort and anxiety that frequently accompany task performance. Hyper-sensitivity to stimuli, a behavioral characteristic of spastics, further elevates muscular tension and generates distractibility and irritability, which increase emotional tension.

As a source of physical and emotional tension, excessive muscle tone is a major problem for spastic cerebral palsied children. Muscle tone reduction is a basic goal underlying much of the treatment and educational programming for this group. Methods that have been effective in treatment include therapeutic handling techniques, movement, relaxation techniques, and stimulus reduction. In physical therapy, positioning to inhibit abnormal reflexes has been used to obtain a more normal muscle tone, making possible more normal postural and movement patterns (Bobath and Bobath, 1964). Placing the child in inverted positions has served to promote relaxation and decrease hypertonicity (Umphred, 1985). Slow, continuous movement, such as rocking (Umphred), and rapid motion experienced in a train or automobile ride (Carlson, 1939), have both been recommended as means of relaxing spastic muscles. Progressive muscle relaxation and rhythmic breathing have been employed to relax the muscles for speech training (Cass, 1965). Finally, the reduction of sensory stimuli through the control of sound,

color, lighting, and arrangement of objects in the environment (Umphred, 1985) has been used to decrease distractibility, thereby lowering emotional and physical tension.

Music has also proven effective as an aid in reducing muscular tension in certain cerebral palsied subjects. Examples are the use of background music during task performance (Schneider, 1956), music accompaniment during therapeutic exercise (Lathom, 1961), rhythmic motion activities using tension and relaxation of muscles (Fields, 1954), and music listening during relaxation training (Scartelli, 1982).

## Need for the Study

It is intended that this research add to the limited amount of literature on the subject of excessive muscular tension in spastic cerebral palsy. Although the literature points to the beneficial effects of music on the cerebral palsied, more evidence is needed as to what music is most effective with specific types of cerebral palsy. Palmer (1953) noted that not all cerebral palsied children achieve relaxation with music, that some become more tense or discoordinated. Concluding that the effect of the music may depend on the type of cerebral palsy the child has, he recommended that music therapists have a good knowledge of the types of cerebral palsy and make careful observation of the physical effects of the music. Schneider's finding (1956) that stimulative music benefited spastic subjects was based on research with a small sample of different types of cerebral palsied children, of whom only three were spastic. Although most of the spastic subjects in Lathom's study (1961) seemed to benefit from stimulative music, each subject showed considerable variability in response, even when performing under the same music or no-music condition. Thus, it is not clear that music type alone governs the response of these children, or that only stimulative music has a beneficial effect on spastics. Scartelli's finding (1982) that sedative music was effective in the relaxation of spastic adults suggests that sedative music might equally benefit certain spastic children.

Because this study focuses on a key problem in the treatment of spastic cerebral palsied children, implications for the effective use of music to reduce excessive muscle tone may provide additional techniques for parents, teachers, and therapists of these children. Types of music that are shown to promote physical relaxation in the subjects in this study might be tested with individual children and incorporated into their programs. For example, specific music might be used effectively to aid a child in movement control while

eating, exercising, or manipulating classroom materials. Music therapy techniques might be made available to physical and occupational therapists who wish to augment current treatment programs, and to teachers and parents who wish to develop music listening programs that produce desired responses in their children.

## Research Questions

Question 1: Does music listening reduce excessive muscle tone in spastic cerebral palsied children, as measured after each listening session?

Question 2: Does music listening reduce excessive muscle tone in spastic cerebral palsied children, as measured at the close of the treatment period?

Question 3: Does the type of music, stimulative or sedative, have an effect on muscle tone reduction?

## Assumptions

It has been noted that cerebral palsied children differ in numerous ways which relate to disability, associated handicaps, and response to the environment (Cruickshank, 1966; Schneider, 1956; Fields, 1954). Accordingly, the behavioral study, which focuses on each subject's unique problems and responses, has been adopted as the basis for this research plan. In this way, subjects' responses to treatment are evaluated

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individually rather than in comparison with a control group.

Cerebral palsied children also vary in their own responses to the environment. Over a three-month observation period of cerebral palsied children, Schneider (1956) noted day-to-day variations in behavior, which he attributed to hypersensitivity, distractibility, and affective tone. Lathom (1961) reported that her subjects reacted to the same music in a different manner on different days. In this study, the time-series design is used to account for variations in individual subject response. It is intended that repeated measures of the dependent variable, degree of muscle tone, will produce a regular pattern of response for each subject, making possible the formulation of conclusions from the research findings.

The use of postural response and midline-reaching as ways to measure changes in muscle tone was recommended for this study by physical therapists currently working with cerebral palsied children. In a study of postural responses of normal subjects to recorded music, Sears (1952) used postural angle as an indication of muscular tension. Fields (1954) stated that relaxation and reduction of tension in brain-damaged patients might be observed through increase in motor coordination and range of motion. In the Bobath neurodevelopmental treatment

(Bobath and Bobath, 1964) used in therapy with cerebral palsied children, the facilitation of normal postures and movements is based on the attainment of normal muscle tone through techniques of handling. The relationship between normal muscle tone and normal postures and movements in the spastic child is explored throughout this study.

## Limitations

The limited number of cerebral palsied subjects who qualified for this study (spastic children, with minimal or no mental impairment, from the Lansing, Michigan, area) dictated the small size of the sample. Because of the small sample size, a statistical analysis could not be applied to the experimental data. While the findings and conclusions of the study indicated the effect of music on the individual subjects, they cannot be generalized to a larger population of spastic cerebral palsied children with minimal mental impairment. The sample included different degrees of disability within the spastic type of cerebral palsy, but did not include an even distribution of ages and a balance between females and males. Therefore, it cannot be viewed as representative of the total population of spastic cerebral palsied children.

Two types of music were used to determine the effect of each on spastic subjects. In order to simplify treatment procedures and maintain consistency in treatment

for each subject, each subject was treated with only one music type. As a result, the effects of the two types of music could not be compared for individual subjects.

There was no attempt to relate what the subjects heard to the musical elements of the pieces that were played. Perceptual-motor disturbances, involving difficulties with auditory and visual discrimination, are common in spastic cerebral palsied children. In the case of auditory discrimination, hypersensitivity to sound, distractibility, and confusion of figure-ground relationships (relationship between a central auditory stimulus and background noise) could interfere with accurate perception of the musical elements distinguishing sedative and stimulative types of music.

## Overview

Chapter II presents a background of this study in a review of related literature. The first section reviews research dealing with music and muscular activity, the middle section describes the characteristics and treatment of cerebral palsy, and the last section reviews music therapy programs and research with the cerebral palsied.

Chapter III presents the methodology used to study the effect of music on the muscle tone states of the subjects. Individual sketches of the subjects are included with a description of the design, sample, and experimental procedures. Chapter IV presents the data in table and graph form, along with a discussion of the responses of the individual subjects to the experimental treatment. Chapter V includes a summary of the study, conclusions based on the results, an interpretive discussion, and suggestions for further research. The appendix contains a glossary of terms, tables of raw data, and forms used to record the responses of the subjects.

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# CHAPTER II

## REVIEW OF RELATED LITERATURE

### Music and Muscular Activity

The influence of music on muscular activity has been a subject of continuing interest to researchers. The study of this subject involves the observation and measurement of changes in muscular tension during periods of activity and relaxation. The discussion of studies on this topic is organized both chronologically and topically in order to present both the scope and focus of the research.

Some early investigations of the effect of music on muscular activity, cited by Diserens (1926), indicated that music increases or decreases muscular energy. In studying muscular tension as manifested in the kneejerk response, Lombard (1887) found that the amplitude of the kneejerk increased with the intensity of an auditory stimulus. Tarchanoff (1895) studied muscular activity during weight lifting, showing that "gay music of rapid movement" overcomes fatigue, enabling additional work, while "sad, slow music in the minor key" causes opposite behavior. Fere (1904) classified melodic intervals as "depressing" or "exciting," and alternated these to produce "oscillations of energy" during weight lifting. Recurrence of the exciting interval resulted in increased muscular energy, while total work was greater under ascending, rather than descending, intervals. Bingham (1910) also used melodic intervals to influence the voluntary muscular movement of finger tapping. His study showed a relationship between direction, size, and consonance of interval and velocity of muscular movement.

Diserens (1926) conducted a variety of experiments at the University of Cincinnati in 1921-22, in which he studied voluntary movement responses involving endurance, speed, and accuracy. Interested in the practical application of music research findings, he stated that "the influence of music on voluntary responses and reactions of the striped muscle . . . must be directly determined if music is to be applied successfully as a regulating and stimulating factor in industry" (p. 155). In his experiments, Diserens studied the effects of contrasting moods ("stirring," "soothing") and tempos (fast, slow) on hand grip strength, accuracy of aim, speed and accuracy of typing, extent and rapidity of line drawing, and speed, size, pressure, and accuracy of handwriting. His general conclusions were that (1) music reduces or delays fatigue, increasing muscular endurance during task performance, (2) music, either fast or slow, speeds up typing and handwriting and reduces accuracy in these activities, and (3) music of either tempo increases the extent of muscular reflexes used in writing and drawing. It should be noted that changes in mood and tempo of the music did not influence the effect of the music on muscular responses in these experiments.

Fultz (1952) also studied muscular activity during task performance, using freehand line drawing as the experimental task. Sixty-two college-aged subjects, who varied in degree of muscular tension, used a specially designed apparatus which automatically recorded drawing movements onto paper, with the number of deviations from straight lines indicating degree of muscular tension. Using music selections described as "hot," "sweet," "stirring," and "quiet," Fultz found that music of all types improved line drawing. He also noted that improvement was transitory, in that the muscular tone of a subject returned to its original deviation rate within four minutes after music listening.

At this point, it is necessary to describe two types of music, stimulative and sedative, which have been commonly used in research on music and muscular activity. These music types were selected for their effectiveness in influencing behavior, by either stimulating or suppressing activity. Radocy and Boyle (1979) described stimulative music as having a strong energizing component, with rhythm the predominant energizing factor.

> Rhythm characterized by detached, percussive sounds stimulates muscular action. March and dance music has definitive and repetitive rhythm which appears to stimulate physical movement. The more percussive, staccato, and accented the music, the greater the apparent physical response to it (p. 240).

Tempo and dynamic level were also mentioned as stimulators in this type of music, with faster tempos and louder levels contributing to the energizing force. In contrast to stimulative music, sedative music was described as

> . . . music which soothes, calms, or tranquilizes behavior. . . . Its melodic passages are sustained, legato, and generally have a minimum of rhythmic activity. The most important rhythmic attribute is the underlying beat, which is usually monotonously regular but subdued (p. 241).

Other characteristics of sedative music included soft dynamic level, slower tempo, and limited frequency range. Lullabies, with their sustained legato melodies and quiet, steady underlying beat, were mentioned as the primary example of functional sedative music. Gaston (1951) effectively captured the differences between stimulative and sedative music by describing and playing an African war dance and a Mozart Adagio for his listeners. While the war dance demanded physical activity and built up physical energy, the Adagio curtailed physical movement and induced a contemplative response. Gaston (1968) noted that research studies of the 1950's using stimulative and sedative types of music nearly always showed significant differences in the responses of subjects. The use of these two music types is an important part of the research discussed in the remainder of this chapter.

Sears (1951) demonstrated the effect of sedative and stimulative music on the muscular tension of 12 subjects by measuring their postural responses during music listening. The subjects were photographed while listening to music selections which alternated between sedative and stimulative types. Postural angle, measured from the photographs, indicated muscular tension during listening. Results showed that posture changed with change in music type, with deviations between postural angles for sedative and stimulative music significantly different at the .01 and .05 levels of confidence. In another experiment, Sears (1960) studied the effects of sedative and stimulative music on tension of the extensor and flexor muscles of the right forearm. He used electromyography (EMG), a process of monitoring the electrical potential produced by muscles, to measure and record the muscle tension level of 45 college students. This process involved placing sponge-type, surface electrodes on the muscles to be tested. The subjects, tested individually, were treated with sedative music during high tension levels, and stimulative music during low tension levels. Results indicated a correspondence between degree of muscular tension and music type, with stimulative music tending to increase tension, and sedative music reducing tension nearly 100% of the time. Treatment was slightly more effective with females and nonmusicians, who responded more in extent and direction than males and musicians.

Safranek et al. (1982) used EMG to measure the effects of auditory rhythm on muscular activity during a motor task. The initiation and duration of biceps and triceps muscle activity was recorded for 24 adult female subjects, who hit targets on a board using flexion and extension of the elbow. The music stimulus consisted of two recorded rhythms, one even and one uneven, in 6/8 meter. Subjects were divided into two groups, one group performing the task to even rhythm, and the other to uneven rhythm. Results showed a significant change in the initiation and duration of muscle activity for subjects in both rhythm groups, a significant decrease in variation of activity for the even-rhythm group, and a significant increase in variation of activity for the uneven-rhythm group. As physical therapists, the authors noted the application of their findings in the treatment of hypertonicity or excessive muscle tone:

> If a therapist wanted to decrease the inconsistent activity of a muscle (e.g., a hypertonic muscle), the therapist could design a repetitive task to an even beat. This would enhance decreased variation in muscle activity and produce more efficient recruitment of motor units. In this manner, the effects of external rhythm imposed on movement could be explored as

> a specific neurological technique to enhance neuromuscular coordination (p. 167).

Two recent studies (Scartelli, 1984; Scartelli and Borling, 1986) examined the effects of varied combinations of sedative music and EMG (electromyographic) biofeedback on the relaxation of muscular tension. Biofeedback is the use of electronic instrumentation to communicate physiological processes. The biofeedback mechanism produces an auditory or visual signal proportional to the physiological activity being monitored, in this case, muscular activity. Electromyographic biofeedback is a form of biofeedback that provides immediate information about imperceptible muscle activity. Subjects using EMG biofeedback easily learn to control their muscles, relaxing or contracting them in accordance with information received from an electronic monitor. Biofeedback has thus proved a useful tool in relaxation training. Scartelli (1984) examined the effects of three conditions--EMG biofeedback paired with sedative music, EMG biofeedback alone, and sedative music alone--on the relaxation of tension in the frontalis (forehead) muscle of 30 normally tensive adults. Degree of muscle tension was indicated by microvolt readings of frontalis muscle activity, with a decrease in microvolts indicating a relaxation of tension. Although no statistically significant differences were found among the three

conditions, results showed that sedative music paired with biofeedback was the most effective condition for decreasing muscular tension in the subjects. In a follow-up study, Scartelli and Borling (1986) compared the effects of sequenced and simultaneous EMG biofeedback and sedative music on the relaxation of the frontalis muscle. Subjects were treated with one of three conditions: simultaneous EMG biofeedback and sedative music, music followed by biofeedback, and biofeedback followed by music. While differences between conditions were not significant, the sequenced presentation of biofeedback and sedative music produced the most reduction in muscle tension levels. In both of the above studies, all subjects treated with music reported that the music helped them relax and maintain concentration for relaxation. The authors suggested that (1) techniques used in these studies be adapted by music therapists using relaxation procedures in treatment, and (2) since biofeedback is not normally available to music therapists, music might be paired with other relaxation methods, such as progressive muscle relaxation, guided imagery, and meditation.

Increased attention to stress reduction in our society has produced a growing body of research on the topic, and has stimulated interest in a variety of approaches to relaxation. In discussing the general features of relaxation, Jacobson* (1929) noted the importance of a physiological component, specifically, control of the voluntary muscles: "If the patient is shown how to relax the voluntary system, there later tends to follow a similar quiescence of the vegetative apparatus. Emotions tend to subside as he relaxes" (p. 32). A number of recent studies have used physiological change to measure the effect of music and other relaxation methods on stress or anxiety. Peretti and Swenson (1974) used galvanic skin response, representing level of skin resistance, to measure anxiety levels in 200 college students. They found that sedative music played during task performance produced a significant reduction in anxiety levels, as indicated by a decrease in GSR (galvanic skin response). Kibler and Rider (1983) measured the effects of sedative music and progressive muscle relaxation (PMR) on the stress levels of 76 college music majors, using finger temperature response as the indicator of stress level. While they found no significant difference among treatment conditions, subjects receiving a combination of music and PMR experienced a greater mean increase in relaxation than the grand mean (mean of all three groups). Rider et al.

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*Jacobson's investigations of muscular states formed the basis of the technique of progressive muscle relaxation.

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(1985) studied the effect of the simultaneous use of sedative music, PMR, and guided imagery (GI) on the activity of adrenal corticosteroids, or "stress hormones." Experimenting with 12 night-shift nurses, who listened to a music/PMR/GI tape over a three-week period, they found a significant decrease in the amplitude of the daily rhythmic curve of the hormones and a significantly greater degree of body temperature and corticosteroid entrainment during treatment days. In discussing the results, the authors pointed out the relationship between high corticosteroid levels and decreased immune response, and noted that the effectiveness of the music/PMR/GI technique had important implications for the treatment of autoimmune and infectious disease.

Some current research has focused on the use of music to reduce tension in medical patients with specialized needs. Hanser et al. (1983) tested the effectiveness of music in decreasing pain responses of expectant mothers during labor. Preferred music, adapted to each subject's pace of breathing, was used as background music for practice of Lamaze relaxation techniques and as accompaniment for breathing techniques during labor. Pain responses were indicated by unrelaxed posture and body movement, unrelaxed breathing, and negative verbalizations. Alternation of music and no-music conditions during labor enabled each subject to serve as her own control. Although the sample was too small to allow for significant results, the authors found a decrease in pain responses for all subjects during the music condition. In a study examining the effects of music on the perceived degree of pain relief of terminally ill patients, Curtis (1986) compared the effects of music with no music and background sound conditions. Although statistically significant results were not achieved, graphic analysis of individual subject responses indicated the effectiveness of music as a means of promoting physical comfort, relaxation, and contentment in the nine subjects who participated in this study.

## Description of Cerebral Palsy

The material in this section originates in greater part from Bleck (1982), chief of orthopedics and rehabilitation services at a large children's hospital. Bleck has provided an informative discussion of cerebral palsy, easily understood by the layman and useful as an introduction for nonspecialists working with CP's. The following information, describing the disorder, has been organized according to Bleck's format: definition, incidence, classification of types, causes, and associated handicaps.

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The term "cerebral palsy" refers to brain paralysis. Cerebral palsy is commonly defined as "a nonprogressive disorder of movement or posture that begins in childhood and is caused by a malfunctioning of, or damage to, the brain" (p. 59). Of cerebral palsy, 86 percent is congenital, caused by disease or disturbance during pregnancy or at birth. While improvements in obstetrical care have led to decreased incidence of some severe forms of the disorder, the improved survival of the premature infant has increased the number of CP cases related to prematurity. Bleck reported that 7 out of every 100,000 children are born with cerebral palsy, and that of these seven, six survive, two requiring institutional treatment, and the remaining four, some form of outpatient treatment.

The types of cerebral palsy are determined by two factors--motor involvement and limb involvement. The principle motor involvement classifications are as follows:

1. Spasticity: characterized by tightness in the limb muscles, which contract strongly with sudden attempted movement or stretching, by exaggeration of movement with repetitive muscle contraction, and by increased deep-tendon reflexes of the involved limbs.

2. Athetosis: characterized by involuntary, purposeless movements of the limbs, and contortion of purposeful movements.

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2. Athetosis: characterized by involuntary, purposeless movements of the limbs, and contortion of purposeful movements.

3. Ataxia: characterized by lack of sense of balance and position in space, and by uncoordinated movement.

Other forms of motor involvement, which may be present in the above types, are rigidity (a severe form of spasticity) and tremor (shakiness of the involved limb). While "mixed" types have both spasticity and athetosis, diagnosis in terms of the major involvement is preferred. Of the three principle types, the spastic type, occurring 65 percent of the time, is the most common.

The principle classifications according to limb involvement are as follows:

1. Hemiplegia: upper and lower limb on the same side.
2. Paraplegia: lower limbs only
3. Diplegia: major involvement in the lower limbs and minor involvement in the upper limbs
4. Quadriplegia: major involvement of all four limbs

When a diagnosis of cerebral palsy is made, both the motor involvement and the limb involvement are specified--for example, spastic quadriplegia.

Each of the three main types of cerebral palsy is related to an area of presumed brain malfunction: (1) spastic: pyramidal system lesion in the cerebral motor cortex, (2) athetoid: extrapyramidal system lesion in the

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When a diagnosis of cerebral palsy is made, both the motor involvement and the limb involvement are specified--for example, spastic quadriplegia.

Each of the three main types of cerebral palsy is related to an area of presumed brain malfunction: (1) spastic: pyramidal system lesion in the cerebral motor cortex, (2) athetoid: extrapyramidal system lesion in the

basal ganglia, and (3) ataxic: cerebellar and brain stem lesion. Bleck maintained that although one movement type predominates, there is considerable evidence that great diffusion of brain malfunction exists.

The causes of cerebral palsy are divided into three main groups: prenatal, perinatal, and postnatal. Prenatal causes include infections in the mother during pregnancy, lack of oxygen to the fetal brain, prematurity, and metabolic disorders. Bleck noted that prematurity causes 33 to 60 percent of all cases of cerebral palsy in the United States. Perinatal causes include birth injury and lack of oxygen, and postnatal causes include head injuries, brain infections, brain hemorrhages, and brain tumors. Sudden, spontaneous brain hemorrhages in children usually cause spastic hemiplegia.

Because cerebral palsy often affects other systems controlled by the brain, it is accompanied by associated handicaps which may be more disabling than the motor handicap. These include speech, hearing, vision, sensory deficits, convulsive disorders, mental retardation, and visual-motor disorders. Bleck noted that 48 to 49 percent of CP children have a speech or language disorder, due either to paralysis or incoordination of the speech musculature or inability to organize and select speech. While hearing loss is not common in spastic children, visual problems affect all types. Sensory deficits are

characteristic of spastic hemiplegia, where loss of shape and texture sensation is common. Convulsive disorders are found in 86 percent of spastics, and affect 55 percent of spastic hemiplegics with postnatal CP. Mental retardation occurs in 75 percent of CP children, with serious mental retardation present in at least 50 percent. Visual-motor disorders, which involve problems in the perception of spatial relationships, are more common in spastic CP, and are usually found in spastic hemiplegics.

## Treatment of Cerebral Palsy

In treating cerebral palsy, attention is focused on motor development because the motor handicap characterizes the disorder, and interferes with growth in all areas of development. Denhoff (1966) contrasted the developmental progress of normal and cerebral palsied infants. Summarizing an earlier study of 100 cerebral palsied children, he noted that the average age of attaining basic motor skills was well beyond the normal age. For example, the average age of attaining head erection in prone position was 12.4 months, and that of acquiring the ability to sit independently was 20.4 months. The average age for crawling was 26.4 months, with 61 percent unable to crawl at all.

Abnormal reflex activity is an important influence on motor development in cerebral palsy. Reflex activities

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Abnormal reflex activity is an important influence on motor development in cerebral palsy. Reflex activities are involuntary reactions to external stimuli which occur naturally in the first year of life, and are inhibited as higher brain centers take over. They serve as the primary information gathering source of the infant, primitive reflexes for nourishment seeking and protective actions, and postural reflexes for maintaining an upright position of the body and preparing for voluntary movements of rolling, crawling, and walking. Abnormal reflex activity is indicated by the persistance of primitive reflexes and the delay or absence of postural reflexes. The presence of abnormal reflex behavior is used in diagnosis as an early indication of neurological dysfunction. For example, when the normal infant's center of gravity is displaced diagonally backwards, the postural reflex response is trunk rotation and protective extension of the arms backwards. However, when the cerebral palsied infant is in the same situation, abnormal postural tone and flexion of the upper trunk prevent the infant from rotating the shoulder back for protective extension of the arm.

In discussing the development of spasticity, Bobath and Bobath (1975) noted the influence of two abnormal postural patterns, flexor and extensor spasticity, on the development of postural control in prone, sitting, and standing positions. They described the sitting posture of the spastic child as follows:

> His head bends forward and downward and his back is flexed. . . . We then see flexion of the spine combined with retraction of the flexed arms, and semi-flexion of the hips and legs with adduction [turning toward the body] and internal rotation. When the child lifts his head, he extends his trunk and hips, his knees extend, and adduction increases and his legs may cross. If not supported, he falls on his back (pp. 17-18).

The Bobaths presented a series of photographs showing motor development in the different types of cerebral palsy. For example, stereotyped abnormal patterns of the spastic quadriplegic child included lack of head control when pulled to sitting, asymmetrical tonic neck reflex (preventing movement out of supine position), total flexor pattern in prone-lying (preventing movement out of prone position), excessive flexion of trunk and limbs (making crawling difficult and slow), and extensor pattern in hips and legs (preventing balance for walking). These abnormal postures not only interfere with functional movement, but often result in contractures and deformities of the spine, hips, and knees.

The Bobath physical therapy technique, neurodevelopmental treatment, is the most commonly used method today for treating cerebral palsy. The technique is based on the inhibition of abnormal postural reflex activity to reduce hypertonicity (excessive muscle tone), and the facilitation of normal postural and movement patterns in the more normal muscle tone state. Treatment involves the practice of normal movement patterns

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Although early diagnoses of cerebral palsy are uncertain as to type, extent, and degree of involvement, the Bobaths recommended early treatment of babies and very young children, who might not have developed appreciable spasticity or fixed abnormal movement patterns. Early intervention would offset the development of faulty movement patterns, and the deformities caused by them, and would facilitate the development of normal patterns in developmental sequence. Because the successful treatment of young cerebral palsied children depends on proper handling and positioning at all times, it is essential that their parents be taught how to handle them at home.

In her excellent guide to the home management of the cerebral palsied child, Finnie (1975) presented handling and positioning procedures designed to improve head and trunk control and overcome deformities. Covering all areas of daily care and including illustrated examples of correct and incorrect techniques, Finnie's suggestions were designed to encourage the cerebral palsied child's independence as well as to solve the management problems of parents.

In his discussion of therapies for the cerebral palsied child, Bleck (1982) noted that the need for intensive physical therapy diminishes after age 7, when walking patterns are set. Accordingly, the emphasis in treatment goals should shift from locomotion training to education, self-care skills, and communication. Along these lines, occupational therapy for the cerebral palsied child has emphasized the development of functional skills for daily living and classroom activities. In discussing occupational therapy with the cerebral palsied, Kiss (1975) listed the primary treatment objective for the child as the development of functional skills normally achieved through play and exploration of the environment. Restricted in movement, the cerebral palsied child is deprived of essential sensorimotor experiences that form the basis of perceptual motor development. Accordingly, the therapist structures the child's environment to facilitate exploration, recommending adaptiquipment and positioning that provide best use of tinds and arms. In her discussion, Kiss noted the iance of helping the cerebral palsied child make more :ive and effective responses to the environment. Th child's difficulties in making appropriate motor nses to stimuli are attributed to a lack of sensory lence on which to organize adaptive motor behavioi Sensory integration is a treatment commonly used by pational therapists to remedy sensory and perce motor dysfunction in cerebral palsy and othenromotor disorders. Treatment involves sensory mulation (tactile, vestibular, or proprioceptive), fod by a functional motor response, which indica sensory integration in the lower brain. A variety ofialized movements are used to provide stimulation produce desired motor responses. For example, spinnie child in a hammock in various positions stimes the vestibular system (balance center of the : ear), helping the child feel the pull of gravind make appropriate postural adjustments. Rolling rocking activities designed to develop body rng and equilibrium reactions are frequently used withhildren to encourage development of normal postural res. By providing the child with an awareness of the ion and balance of the body, sensory integrationivities develop motor behavior enabling the cerebral palsied child to accommodate to the environment.

Noting the increasing emphasis in occupational therapy on perceptual and visual-motor training, Bleck (1982) advised the development of compensatory skills to offset visual-motor losses of cerebral palsied children: "Instead of struggling to achieve a slow, laborious handwriting, some children might benefit more from learning to use the electric typewriter" (p. 89). Bleck stressed the importance of mechanical devices to the physically handicapped in a section on rehabilitation engineering. He called attention to applications of the microprocessor--programmed computers, environmental control systems, and synthetic voice devices, which are expected to make substantial improvements in the quality of life for the physically disabled. Other mechanical aids include orthotics (fabricated lower limb supports made of plastic) and seating and mobility devices. Contoured wheel chair inserts provide trunk stability for operating mechanical devices, while power wheel chairs driven with hand, head, or foot controls increase mobility and independence. Special electronic switches are used to aid children who lack adequate upper-limb control and dexterity in the operation of these chairs.

A thorough presentation of the use of speech therapy with the cerebral palsied can be found in Cass

(1965), whose book includes theory, methodology, and training activities. Cass's approach is based on the principles of muscular reeducational therapy, developed for use in physical therapy by the orthopedic surgeon, Winthrop Phelps. The approach involves building the residual abilities of affected muscle groups, and supplementing these abilities by increasing the function of normal adjacent muscle groups. Cass applied the approach to speech therapy as follows:

> Understandable speech can be produced by using a few minimum essential patterns of movement, and these patterns may be produced in more than one way. So, if a mechanism is defective in function, it is imperative to choose the ways and means most effective for its rehabilitation . . . either one of reeducating the muscles already in use or of circumventing the difficulty by building a usable pattern which is essentially normal, acoustically, but not necessarily produced with the identical movements used by the average person to produce the desired sounds (pp. 51-51).

Because speech abnormalities in cerebral palsy arise chiefly from problems with motor interpretation, Cass defined her goal as usable speech, not refinement. General bodily relaxation and muscle control were emphasized as prerequisites for relaxation of the speech mechanism. Verbal imagery and soft, restful music were recommended to promote relaxation. Methodology incorporated the use of musical patterns to facilitate pronunciation and strengthen vocalization. Jingles with a fixed stress pattern established and reinforced desired breathing patterns, and familiar tunes provided a setting for the practice of specific sounds.

Although music therapy is normally not included with basic treatment for cerebral palsy, there are additional examples of the use of music in the therapeutic literature. In a discussion of physical therapy procedures for the cerebral palsied, Snell (1955) presented adaptation of the Mary Trainor therapeutic exercise program, which involved conditioned reflex training using music as a stimulus. Working toward the goal of independent movement, the physical therapist took the child through a range of motion while singing a specific song. Parents were taught to carry out the exercises at home, with the aid of music to stimulate and reinforce movement. Gillette (1958), in an overview of exercise programs for cerebral palsy, described the method of Winthrop Phelps, who used a combination of rhymes and music together with desired movement patterns in treating young children. The use of a different song for each movement conditioned patients to respond to a particular music stimulus with a specific movement. Patients progressed from passive range of motion exercises through active assisted motion to active motion, all accompanied by musical rhyme. Once the association was established between a musical rhyme and movement, the child was breathing patterns, and familiar tunes provided a setting for the practice of specific sounds.

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## Music Therapy Programs with The Cerebral Palsied

There are many examples in music therapy literature indicating the benefits of music treatment for the cerebral palsied. In discussing the uses of music therapy with cerebral palsied children, Ford (1984) stated that musical experiences provide the physically disabled child with an opportunity for group activity, an outlet for emotional expression, and a basis for the development of leisure time skills and interests. Outlining the clinical application of music experiences in the areas of cognitive, physical, speech, and social-emotional development, she emphasized the effectiveness of music as sensory stimulation and motivation for movement in the treatment of cerebral palsied children.

Specific music therapy programs with cerebral palsied children were described by Snow and Fields (1950) and Weigl (1954), who used music to stimulate physical activity, strengthen muscles, and improve coordination. Incorporating some of the gross and fine motor exercises prescribed by the children's physical and occupational therapists, these programs used music stimuli as an adjunctive aid in therapy. Snow and Fields reported progress over a one and one-half-year period with 12 children ages 6 to 16, who were enrolled at a neurological institute. Weigl, working in a New York City public school, maintained that physical therapists saw better results from treatment when exercises were accompanied by rhythmical music and action songs. Activities in these programs included walking, arm swinging, and playing rhythm instruments, with slow tempos and dynamic changes used to promote movement control.

Fields (1954) reported measurable improvement in gross and fine motor coordination in 24 of 28 cerebral palsied patients, ages 15 to 52 years, with varied diagnoses and associated speech and sensory handicaps. The music treatment, administered over a three-year period at a neurological institute, focused on the improvement of muscular activity and purposeful movement through patient participation in rhythm instrument and keyboard activities. Use of the hand drum promoted flexibility of wrist action and rhythmic coordination of symmetrical and reciprocal movements of the hands and feet, while piano keyboard activities improved independent finger action and range of motion in the shoulders. Movement was reinforced by music accompaniment, adjusted to each patient's speed of motion. Patterns of relaxation and tension in rhythmic motion, taught as the basis of purposeful movement, were accompanied by music arranged to fit the patterns.

Coordinated motions achieved in music activity were successfully transferred to daily life and work activities such as dressing, eating, and typing. Fields noted that this transfer occurs "when the patient can see relationships between organization of motion in various activities," and that "learned rhythmic patterns of motion can be successfully integrated into other activities when the tasks can be manipulated to meet the patient's trained rhythmic motion" (p. 282).

Westlake (1951) recommended the use of music in speech therapy with cerebral palsied children. Noting that inability to sustain phonation was a common speech problem in cerebral palsy, he suggested singing as a way to encourage sound production and the prolongation of sounds. To facilitate responses, Westlake advised slowing down the tempos of songs and using simple tunes with repeated melodic and rhythmic patterns.

Rudenberg (1982) presented case studies of cerebral palsied children and adolescents, describing their progress during individual music therapy sessions. The benefits of treatment included increased range of motion through movement to music, increased vocalization and imitation of vocal sounds, and increased arm strength and range of motion through playing keyboard instruments. In an earlier case study, Josepha (1960) reported improvement in finger independence and two-hand coordination in a nine-year-old who received private piano instruction. Additional benefits of music therapy for this child were increased attention span and acquisition of music reading skill.

James (1986) described the use of music with sensory integration techniques in a six-month treatment study with a 20-year-old mentally impaired spastic quadriplegic. Treatment was designed to elicit protective equilibrium responses and reduce the incidence of primitive reflex posture. Activities included rocking on a ball and rocking board to the accompaniment of slow, "soothing" guitar music. Posttreatment assessments revealed positive results for desired movement responses, and also indicated improvement in eye contact and spontaneous verbalization.

Krout (1987) described a group music therapy program serving six severely involved adolescents in a special education setting. Sessions were structured to enable students to work on target behaviors designated in their individual educational plans. Long-term goals for individual students included improved eye contact, upright head position, increased use of communication boards, purposeful arm and hand movement, and increased vocalization though singing activity. All students improved during one ten-week reporting period, either showing progress or meeting their targeted objectives.

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Additional skills were taught in the context of specific music activities. Rhythm activities, for example, developed eye-hand coordination, gross and fine motor movements, and auditory discrimination. Activities were designed to encourage participation at each student's level, so that a singing activity might involve the student in any one of the following roles: singing, vocalizing, choosing songs, clapping, or listening. All activities developed appropriate social behavior through interactions such as dancing, sharing materials, and listening to others.

Bixler (1968) and Rudenberg (1982) emphasized the influence of music therapy on the social and emotional development of cerebral palsied children and adolescents. Bixler noted increased initiative, enthusiasm, and self-confidence in cerebral palsied hospital school students who participated in operetta productions. He saw the experience as providing a group identity for the physically handicapped adolescent, whose lack of mobility and communication interfered with participation in group activities. Rudenberg presented the case studies of two adolescent males who received private instrumental lessons. Learning to play the chord organ or guitar provided each of these clients with a leisure-time activity that encouraged self-expression and promoted peer interaction through shared music experiences.

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## Music Research with the Cerebral Palsied

Music research with cerebral palsied subjects has investigated the effect of music on task performance, physical control, mood, and muscular tension. One of the most influential studies was that of Schneider (1956), who examined the influence of background music on the quantity and quality of the productive work of ten cerebral palsied subjects, ages 8 to 19 years, during the performance of a fine motor task. Schneider also measured the effect of the music on attention, motor control, and mood level during task performance. The subjects varied in type of disability; five were diagnosed as athetoid, three as spastic, one as mixed, and one as ataxic. Two psychomotor tasks, pegboard and coloring, were performed under three experimental conditions: no music, physically sedative music, and physically stimulative music. Physically sedative music was defined as that having flowing melodies, smooth rhythms, moderate tempos, smooth modulations, and a predominant use of strings and winds. Physically stimulative music was defined as that having marked rhythm, fast tempo, staccato type melodies, syncopated musical figures, and a predominant use of brass and percussion.

Schneider found that stimulative music exerted a more positive influence on performance behavior and task production of the spastic subjects, while sedative music produced the same effect for the athetoid subjects. In the case of the spastic subjects, stimulative music tended to increase the quantity and improve the quality of production. Stimulative music also seemed to have a beneficial effect on the performance behavior of the spastic subjects in that motor control, attentiveness, and emotional stability increased under this condition. In contrast, sedative music tended to decrease the quantity and quality of work of the spastics. It seemed to have a detrimental effect on their performance behavior, resulting in decreased motor control, increased distractibility, and more excited and less stable emotional tone.

The significance of Schneider's research lay in his finding of a relationship between type of cerebral palsy and type of music, as indicated by the differing responses of spastic and athetoid subjects to stimulative and sedative music. Although Schneider's sample was small, his conclusions laid the ground work for further research on cerebral palsy, and suggested ways in which music might be effectively used to treat the disorder. Discussing the implications of his findings, Schneider suggested that

> recorded music might be used in many different ways to enhance various aspects of the therapy and educational programs of cerebral palsied children. [It] might be used as a mood setting device, or as a device for motivating certain

> activities, particularly those employing psychomotor performance (p. 274).

Ditson (1961) found that background music promoted a positive attitude toward treatment in 21 young cerebral palsied children, ages 18 months to 4 years. Studying the effect of stimulative and sedative music on the behavioral responses of the subjects during treatment, she found a significant increase at the .005 level in participation and socially acceptable behavior.

Lathom (1961) demonstrated the effect of music on the control of movement in a physical therapy setting. She studied 12 subjects, ages 11 to 16, whose diagnoses represented the different types of cerebral palsy. The subjects rode a stationary bicycle and used a wall pulley under conditions of no music, sedative music, and stimulative music, the last corresponding to the rhythm and tempo of the activity. Physical control was indicated by regularity of performance, as measured by the number of movements for each 10-second interval of activity. Subjects had more control when performing under conditions of one or both types of music, with athetoid subjects responding more favorably to sedative music and most of the spastic subjects, to stimulative music. Lathom also observed that

> sedative music, which is usually considered to be relaxing, may not be beneficial to the increased physical control of some children. For some children, stimulative music appears more

> beneficial. This might be caused by the increased effort these children seem to exhibit in response to stimulative music (p. 16).

Given the different responses of spastic and athetoid subjects to music type, Lathom concluded that an effective application of music in therapeutic settings for the cerebral palsied would require that spastic and athetoid patients be treated separately.

Staum (1983) studied the effect of music and auditory stimuli on the facilitation of gait control in 25 physically handicapped subjects, four of whom were cerebral palsied. Subjects walked to marches and percussive rhythmic pulses that were recorded at tempos to correspond with individual walking speeds. All subjects improved in rhythmic walking during music conditions, with 88% maintaining improvement during fading procedures, and 68% of the subjects improving in consistency of speed. Results were significant at the .001 level. Both of the spastic cerebral palsied subjects showed substantial improvement in rhythmic walking, while one improved markedly in consistency of walking speed. Because Staum's subjects differed widely in age and disability, her findings cannot be applied to specialized groups, such as cerebral palsied children. However, her work pointed out the effectiveness of music as a tool in physical rehabilitation, and provided a strong base for further research confined to specific disorders.

Conrad and Bleck (1980) used an auditory stimulus to reinforce correct gait in the treatment of eight children (six with spastic cerebral palsy), whose problem was equinus gait or toe-walking. A pressure-sensitive foot switch, placed under the heel of the subject's shoe, acted as a signal device when the desired response of heel contact was made during walking. Improvement in duration of heel contact and range of motion in ankle movement was shown by every subject at the conclusion of treatment. In this study, Conrad and Bleck successfully demonstrated the positive effect of auditory feedback on the motor performance of subjects with a specific motor problem in common.

Wolfe (1980) used music stimuli to reinforce desired head posture in 12 spastic cerebral palsied subjects, ages 3 to 37 years, who differed in degree of mental impairment. Two music conditions (interrupted music/silence and interrupted music/tone) were contingent on the control of erect head posture, which was measured by duration and frequency of change in head position. Because of the wide age range of the subjects, music selections were chosen from a variety of categories, including nursery songs, rock-and-roll, folk, light classical, and marches. Wolfe attributed the limited improvement of the subjects to low attention levels and distraction from surrounding noise, and concluded that the development of selective listening in cerebral palsied subjects would be requisite for the effective use of auditory stimulus in enhancing motor control.

Herron (1970) studied the effect of instrumental training on the fine motor coordination and breath support of four subjects, who represented spastic and athetoid types of cerebral palsy. After learning to play the melodica, a wind instrument with a piano-type keyboard, the subjects were tested for the ability to coordinate hands and fingers, sustain tone, coordinate blowing and fingering, and perform musically. Improvement varied with individual subjects and depended on degree of disability and mental impairment. While severe muscular dysfunction resulted in low musical achievement for the spastic subject, improvement in muscular coordination and breath support was noted.

The research of Berel et al. (1971) illustrated the use of auditory stimuli to facilitate the performance of a spatial task. Thirty-four young cerebral palsied children, varying in type and severity of involvement, followed and imitated a series of patterns played on eight diatonic tone bells arranged in three-dimensional stepwise fashion. The stimulus was given under both visual and auditory-visual conditions, with the instrument placed in different positions. Performance was significantly better under the auditory-visual condition than under the visual condition, implying the usefulness of auditory feedback in teaching cerebral palsied children with learning problems.

The two remaining studies to be discussed investigated the effects of music stimuli on involuntary movements of cerebral palsied subjects. Palmer and Zerbe (1945) examined the effects of tones and rhythms, produced primarily by the violin, on finger tremor in an adult male subject with both spastic and athetoid symptoms. The authors found that the music stimuli produced an increase in the severity, rate, and stability of the tremor, while the sudden cessation of the stimuli resulted in remission of the tremor for a considerable length of time. The best results were obtained with instantaneously loud sounds played on the orchestra bells or violin. Scartelli (1982) compared the use of sedative music and biofeedback assisted relaxation training on the relaxation of the finger extensor muscles of the arm in six spastic cerebral palsied adults. He found that subjects treated with music experienced a 65% mean decrease in muscle tension, while those treated with biofeedback experienced a 32.5% mean decrease in muscle tension. Although the sample size was too small to permit statistical analysis, the findings showed a definite relationship between sedative-music treatment and the reduction of excessive muscular tension in spastic cerebral palsied subjects.

## Summary

The effect of music on the muscular activity of normal subjects has been observed through changes in energy level, speed, accuracy, and patterns of electrical activity during task performance. Two contrasting types of music, stimulative and sedative, have been shown to produce different muscular responses in both normal and abnormal subjects. Sedative music, used alone or with other relaxation techniques, has been effective in reducing muscular tension in normal and specialized subject groups.

Cerebral palsy is a nonprogressive disorder of movement caused by brain damage before, during, or following birth. Spastic cerebral palsy is a specific type of the disorder, characterized by excessive muscle tone or tightening of the muscles and an exaggeration of movement accompanied by muscular contractions. The basic treatment of spastic cerebral palsy includes physical, occupational, and speech therapy to develop more normal function in a reduced muscle tone state. Music therapy programs for the cerebral palsied have served primarily as adjunctive aids in therapy, providing motivation for exercise, promoting control of movement, and facilitating relaxation. Music activities have also provided cerebral palsied children with much needed opportunities for emotional expression and social interaction.

Music research with the cerebral palsied has shown positive effects of music on task performance, movement control, mood level, and muscular tension. Some specific uses of music were to establish mood, cue movement, reinforce desired responses, and develop fine motor coordination. Current research shows that music can be successfully incorporated into sensory integration treatment, special education programs, and relaxation training. The literature stresses that music type (sedative or stimulative) is a key fact to consider when treating the different types of cerebral palsy.

# CHAPTER III

# METHODOLOGY

## Design

This study adopted a single-subject design using a pretest-posttest in repeated measures of the dependent variable, muscle tone state. The independent variable was a 5-minute music listening session using recorded selections of stimulative or sedative music.

## Sample

The sample consisted of eight cerebral palsied children, male and female, at the elementary and middle school levels, diagnosed as spastic, moderately or severely involved, with minimal or no mental impairment, and with normal range of hearing. Subjects were drawn from two schools in the Lansing, Michigan, school district.

The subjects were referred by their physical therapists, who described them according to extent and degree of neuromotor involvement. The extent of involvement refers to the parts of the body affected by the disability (upper limbs, lower limbs), and the degree of involvement refers to the effect of the disability on physical performance. In the subject sketches which follow, each subject is described as to extent and degree of neuromotor involvement, functional motor skill ability, and current treatment goals. This information provides some background for understanding the disability and is considered important to the interpretation of the findings of this study.

The original number of subjects referred for this study was ten, three males and seven females, with ages ranging from 5 to 13 years. Two subjects were dropped from the study while research was in progress, one female, age 6, because of an error in diagnosis, and one male, age 5, because of lack of cooperation. The remaining eight subjects, two males and six females, are described individually in the subject sketches that follow.

Subject A, an 11-year-old female, is a severely involved quadriplegic, with spasticity evident in all parts of the body. Speech and movement require a great deal of effort, and frequently elicit abnormal postural reflexes, which increase muscular tension. The subject moves about in a motorized wheel chair, which she operates with a gross movement of the right hand, while the left hand is strapped down to limit extraneous movement and maximize control of the active hand. She receives physical, occupational, and speech therapy as part of her school program. Her main goal in physical therapy is maintenance of joint mobility, accomplished through changing positions and passive movement. She is positioned on the floor for range of motion exercises for all extremities, and especially benefits from exercising in the water, which promotes relaxation as well as increased range. Treatment in occupational therapy focuses on developing pre-vocational skills and leisure activities. With the aid of a hand splint, the subject explores ways to grasp, pull, and drop objects. Unable to manipulate materials, she takes a decision-making role in crafts projects, choosing colors, shapes, and patterns. In speech therapy, the goals are increased breath control and improved intonation. Specifically, the subject is working on increasing the number of spoken words per breath and adding more stress patterns to her speech. On initiating speech, she tends to revert to abnormal reflex patterns, which emphasize tongue protrusion. To overcome this problem, the therapist uses relaxation techniques which include positioning on the floor with head forward, bouncing, and verbal suggestion. The subject is classified as Educably Mentally Impaired, is mainstreamed in the fifth grade for group-oriented subjects, and receives individual and small group instruction in a self-contained upper elementary classroom for physically handicapped students. She is positioned in a wheel chair for most classroom activities, with secure supports for shoulders, trunk, legs, and feet. She is visually impaired, diagnosed as legally blind with glasses. Learning materials include talking books, camera-enlarged print projected on television monitor, and switch-operated computer programs for writing and spelling. A midday rest and relaxation period using music has been found beneficial to the subject's afternoon performance in the classroom.

Subject B, a 12-year-old female, is a severely involved quadriplegic. She is rigid in most positions, with movement of the head and chin her only voluntary movement. Her head and arms are locked into a pattern of extension and flexion movements, with movement of the arms dependent on position of the head. She receives physical, occupational, and speech therapy as part of her school programming. Her goal in physical therapy is relaxation, achieved through passive range of motion exercise and position changes for more effective movement. For example, the subject is placed in supine position for stretching of the leg muscles from the hip and knee joints. Passive motion in water heated to 88 degrees is especially relaxing, with the subject buoyant in a special flotation device. Because she tightens on intention of movement, Subject B lacks the capability for effective manipulation with her hands. Her occupational therapist is presently developing adaptive devices which she can operate with her head and chin. These include a helmet with attached spoon for self-feeding and a chin-operated switch for turning on lights and electronic equipment. A crayon holder strapped to the hand for drawing provides leisure activity and helps to maintain present range of motion. In speech therapy, the subject's goals are breath control and articulation. Because of excessive muscular tone, she takes too much air, exhales all at once, and forces speech out. Controlled breathing is used to relax her and help her initiate requests in complete sentences. An important part of speech therapy for this subject, relaxation can be accomplished by controlled breathing within several minutes. The subject functions at the Educably Mentally Impaired level, and receives instruction throughout the day in a self-contained classroom for physically handicapped students. For the best function and least amount of extraneous movement, she is seated in a wheel chair, with support for head, shoulders, trunk, legs, and feet. In addition to a severe motor impairment, a visual impairment, distractibility, and a short retention span further restrict the subject in her learning environment. Since she learns best through the auditory mode, most learning materials are taped, while visual materials are enlarged by camera and presented on a closed-circuit television. As in speech and physical therapy, relaxation is considered an important part of the subject's classroom routine. Her teacher finds that controlling the environment by providing a calm setting with minimal stimuli is an effective means of reducing physical tension. The subject also derives relaxation from wheel chair aerobics, with movement helping to loosen muscles as she participates in guided range of motion exercises.

Subject C, a 13-year-old female, is classified as quadriplegic with moderately severe involvement. She moves about in a motorized wheel chair, which she operates independently with the right hand. Her left arm is contracted, with elbow and wrist in flexion and arm adducted. While the arm and hand are seldom in use, there is fair to good sensation, with surgery recommended to release tightness in the joints. The subject receives physical, occupational, and speech therapy as part of her school program. Physical therapy emphasizes active motion of the lower extremities, involving changes of position. Swimming provides a recreational outlet and facilitates leg movement in back floating position. Occupational therapy stresses increased function of the subject's "good" hand through such activities as handling materials, cooking and sewing. Improvement in movement quality and attentiveness to task are important objectives within this goal area. Subject C's possibilities for vocal communication are limited because of severe involvement of the tongue. Her principle method of communication is a speech computer that vocally synthesizes and prints out words that she spells and punches out on a keyboard. Her work in speech therapy focuses on maintaining present vocal abilities, with emphasis on beginning and ending consonants, and lip closure combined with swallowing as a means of decreasing drooling. The subject is mainstreamed in the sixth grade for academic subjects, and participates in a special education classroom for physically handicapped at the beginning and end of the school day. Adaptations for speech and visual handicaps include large-print books, hand written communication, dictation from the blackboard, and extra time to complete tasks. The subject functions in the low normal range of intelligence and is easily distractible. Normally tense and inclined to worry, she is faced with numerous obstacles in the educational setting. Central to the effectiveness of her educational program are a highly structured learning environment and means of relaxation for controlling negative emotional states that interfere with learning and overall functioning.

Subject D, a 5-year-old female, is diagnosed as spastic diplegic, with moderately severe involvement of the legs and a lesser degree of muscular tension in the arms. She locomotes independently in a motorized wheel chair and crawls with a nonreciprocal pattern. She wears glasses to correct a visual impairment, which involves poor ocular control, as well as low vision. While the subject exhibits spasticity during activity, she shows low tone when at rest. This pattern is often seen in spastics, who use tight muscles during movement. Treatment is directed toward accentuating the use of normal muscles by decreasing the high tone of spastic muscles and increasing the tone of muscles in a floppy or low tone state. In physical therapy, the subject practices head control, while sitting on a low bench without support, and while floating on her back in the pool. Placed on a ball which is tipped in different directions, she rights herself by extending the hand and trunk. Although she can use a walker, she takes very small steps, has poor trunk control, and needs maximal assistance. In occupational therapy, she works in different positions, using an adapted chair and table to inhibit forward flexion and a standing position to encourage reaching with wrist extension. The occupational therapist uses activities that address both motor and visual handicaps, such as manipulative games and puzzles, independent dressing, and chair travel, which involves control of eye movements for spatial judgments. Subject D is of normal intelligence, and has participated in her school's POHI program for three years. She presently attends school for a full day, placed in a self-contained classroom with a small group of physically handicapped peers. She learns best through the auditory mode, with story and song materials, both live and taped. Naturally quiet and shy, she makes effective use of the class's daily rest and relaxation period.

Subject E, an 8-year-old male, is a spastic quadriplegic with moderately severe involvement of the shoulders, trunk, and legs. His primary means of locomotion is a motorized wheel chair, which he operates by stick shift with relative ease. The subject has best control of upper body movement when stabilized in the chair, with supports for shoulders, trunk, legs, and feet. Although able to use a walker, he walks with a very stiff, labored gait, conscious effort, and a high expenditure of energy. His physical therapy program focuses on normalizing muscle tone and improving the quality of movement patterns. Stretching and rotating of the lower body are used to loosen muscles before walking.

At present, the subject walks on the balls of his feet and is unable to move with a reciprocal pattern; he will be a household ambulator rather than a functional walker. He has a high resting tone, which he uses to advantage in activity. Because of his overall muscular tightness, he particularly benefits from relaxation exercises done in the pool. Reduction of muscle tone through relaxation is the subject's major goal in occupational therapy. Here, rocking on a large ball is used to loosen the muscles and facilitate deeper breathing. Work also focuses on the rotation of isolated body parts, a particularly difficult area for the subject, and improvement of daily living skills, such as dressing and locomotion. The subject functions in the normal range of intelligence and is mainstreamed in the second grade. He receives individual help from a special education teacher consultant in reading, spelling, and writing, where difficulties are caused by poor eye movement and lack of fine motor control. The subject requires ample time to perform well since hurry increases muscle tone, thereby decreasing manual control. His motor impairment affects not only fine motor and eye movements, but also lung capacity, causing a breathiness of voice. Proper positioning for classwork is important for providing both upper body support for tasks and relaxation of tight chest muscles for improved speech.

Subject F, a 7-year-old female, is a severely involved spastic diplegic with greatest degree of involvement in the legs and hips. Because of a pelvic deformity resulting from spasticity, the subject's right leg is longer than her left. She moves independently in a self-propelled wheel chair, and is currently learning to operate a motorized chair. In physical therapy, the subject works to increase range of motion in the hips, which are severely contracted, and to increase trunk strength through rotation and extension of the upper back. She is normally flexed when in seated position, and is unable to rotate the trunk independently. Activities include stretching the legs in prone position, push-ups, and reaching across the midline to manipulate objects. Emphasis is placed on rotating the trunk while keeping the pelvis still, and on discouraging the subject from leaning backwards to compensate for lack of trunk control. The subject's visual impairment creates severe perceptual problems, placing her at a 3-year-old level in visual motor skills. Her occupational therapist works to improve her hand-eye skills, using prewriting activities involving cutting, tracing, and copying. Subject F functions at the low normal range of intelligence, is placed in a self-contained POHI classroom for basic academic subjects, and is mainstreamed in the first grade

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Subject G, a 6 1/2-year-old male, is a spastic hemiplegic with moderate involvement of the right side. His gait is characterized by decreased stride, hip rotation, forward sag of the back, and internal rotation of the right foot. His right arm, formerly locked in an upward flexed position, has responded to treatment with a splint so that it is in normal position, allowing use of the arm, hand, and fingers. At present, the subject requires only consultative treatment in physical therapy for the purpose of maintaining current joint mobility. In occupational therapy, his goal is to strengthen the right hand for two-handed activities. He works on grasp-release exercises, and wears a thumb sling for proper thumb position. The subject receives speech therapy for a severe articulation disorder, which is regarded as a learning problem related to the perception of sound patterns. For example, he interchanges initial consonants, deletes final sounds, and omits unstressed words from speech. While he is of normal intelligence, he is behind his age group in school. He attends regular education kindergarten in the afternoon, but is placed in a self-contained POHI class for the morning so as to participate in the school's therapy program. Classroom techniques used to help the subject with communication include repetition of speech to insure understanding, ignoring of his stuttering habit, and short time outs for relaxation when needed. The subject does not require adaptive equipment for fine motor work, and is encouraged to use his involved side to manipulate materials in his own way.

Subject H, a 13-year-old female, is a right hemiplegic with a moderate degree of involvement. Brain damage has resulted in an overflow to the right side of the brain, so that activity on the right of the body causes a reaction of muscular tightening on the left. The subject walks independently, with gait characterized by severe flexion of the hip, knee, and ankle, and some internal rotation. She holds her right arm in flexed position, with index finger bent backwards. Treatment in physical therapy focuses on maintaining range of motion in the right hip, knee, and ankle, with ankle surgery currently recommended. Occupational therapy emphasizes functional hand skills needed for the manipulation of materials and tools. The subject is of average intelligence, and is mainstreamed in the sixth grade for academic subjects. During the first and last periods of the school day, she meets with other physically impaired students in a self-contained classroom, where she works on prevocational skills, and learns to adapt her environment to meet her limitations. For example, she must allow herself more time to plan and carry through a task in order to overcome poor organization skills, caused in part by her physical handicap. Inclined to stutter when excited or under stress, she is able to control her speech with relaxation techniques, which include verbal reminders and deep breathing. Relaxation has become an important coping tool for the subject, who is presently working toward more awareness of when and how to incorporate its techniques into her daily routine.

Table 1 presents a summary of subject variables, describing the subjects as to sex, age, and impairment. Extent of impairment indicates the limbs affected by the disability, and degree of impairment indicates the effect of the disability on physical performance.

## Experimental Procedure

The subjects were treated individually in eight 15-minute sessions, scheduled twice weekly over a period of four weeks. Sessions were held in one elementary and

Table 1. Description of Sample

| Subject | Sex | Age | Impairment | |
|---|---|---|---|---|
| | | | Extent | Degree |
| A | F | 11 | Quad | S |
| B | F | 12 | Quad | S |
| C | F | 13 | Quad | MS |
| D | F | 5 | Di | MS |
| E | M | 8 | Quad | MS |
| F | F | 7 | Di | S |
| G | M | 6 1/2 | Hemi | M |
| H | F | 13 | Hemi | M |

Code: Quad = Quadriplegic

Di = Diplegic

Hemi = Hemiplegic

S = Severe involvement

MS = Moderately severe involvement

M = Moderate involvement

one middle school in a small, enclosed space provided by school personnel. The researcher conducted all sessions, and was responsible for the measurement and recording of subject performance. Session one was used to acquaint subjects with the researcher and treatment procedures, and to obtain baseline measures of the dependent variable. Session two was used as an additional pretreatment session for purposes of adjusting the level of task difficulty to the individual abilities of each subject. The experimental treatment was administered in sessions three through eight, with a reversal condition (no music) used in session six. A detailed description of session procedure follows.

Subjects were escorted to the treatment room by the researcher, and were seated throughout the session in their own wheel chairs or, if ambulatory, in a straight backed desk chair. Wheel chair supports for upper body and legs were used to facilitate task performance and insure the comfort of each subject during treatment. Since subjects were accustomed to these supports, the researcher assumed their minimal interference on any changes in muscle tone state that might occur during the sessions. Each session included videotaping of the subject's resting posture before and after treatment, performance of a simple arm motion task before and after

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treatment, and quiet listening to recorded music. The specific procedure for each session was as follows:

1. Positioning of subject against wall at far end of room
2. Brief conversation with subject to establish rapport, review procedures, and explain purpose of study--to find out "if listening to music helps kids relax"
3. Pretest:
    a. Videotaping of normal resting posture of subject (approximately 30 seconds)
    b. Performance of arm motion task by subject. Observation and recording of subject performance by researcher
4. Quiet listening to recorded music (5 minutes)
5. Posttest
    a. Videotaping of normal resting posture of subject (approximately 30 seconds)
    b. Performance of arm motion task by subject. Observation and recording of subject performance by researcher

The researcher adopted the following system of cues to meet the subjects' needs for review of task performance procedures:

"Use your [right or left] hand." (point to hand)

"Put your hand on the ring."

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   b. Performance of arm motion task by subject. Observation and recording of subject performance by researcher

The researcher adopted the following system of cues to meet the subjects' needs for review of task performance procedures:

"Use your [right or left] hand." (point to hand)

"Put your hand on the ring."

"Push it as far as you can." (Point to indicate direction of movement)

"Then stop."

Subjects were encouraged to sit naturally during the videotaping portions of the session, to make themselves comfortable at the start of the music listening period, and to listen quietly to the music. Each subject was given positive feedback for cooperative behavior during the session.

## Experimental Tasks

The dependent variable, degree of muscle tone, was measured by (1) a comparison of subjects' resting postures before and after treatment, and (2) a comparison of subjects' ranges of motion in an arm movement task before and after treatment. Recording of the subjects' resting postures preceded task performance in both pretest and posttest portions of the session. This permitted immediate recording of any effects of the music on resting posture, and prevented additional movement during task performance from interfering with the muscle tone state of the subjects when at rest.

Observation of resting posture is a qualitative measure of degree of muscle tone, frequently used by therapists in evaluating spastic patients. The normal resting posture of a spastic cerebral palsied patient is

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Observation of resting posture is a qualitative measure of degree of muscle tone, frequently used by therapists in evaluating spastic patients. The normal resting posture of a spastic cerebral palsied patient is often characterized by a tightening of muscles that pulls the body into an abnormal position. A stereotypic posture might involve any or all of the following:

1. Head: Held in extended position and away from midline
2. Trunk: Extended position
3. Arms: Held away from the body (abduction) in flexed or extended position
4. Wrist: Flexed position
5. Hands: Thumb tucked into palm, fingers clenched
6. Legs: Turned in toward body (adduction)

Any observable changes in resting posture involving a closer alignment of the body parts and a relaxation of parts held in rigid position would imply reduction of muscle tone. While this general statement can be made, individual differences arising from degree of impairment and positioning are important factors to consider in an evaluation of resting posture. This issue is discussed further in Chapters IV and V.

During each session, the researcher recorded the resting posture of each subject in two 30-second videotapes, taken before and after the music listening period. Each 30-second recording included a full view of the subject, followed by close-ups of the head, face, and hands, and a final full view. The camera was placed on a tripod at the wall opposite from the subject and positioned to afford a full view of the subject in seated position. Pretest videotaping occurred after the subject had become accustomed to the surroundings and the researcher, while posttest taping followed the music listening period without interruption. Video equipment included two JVC cameras and video cassette recorders, two tripods, and two TV receivers. Video recordings were taped on two Memorex HS 120 video cassettes.

Assessment of range of motion is a quantitative measure of degree of muscle tone. Range of motion in the shoulder and elbow can be measured through forward arm reaching to, across, and around the midline. During activity, increased muscular tension in the spastic often inhibits movement toward the midline of the body. Thus, an increase in range of motion enabling arm movement toward and across the midline would indicate a reduction in muscle tone.

The arm motion task originally designed for this study involved movement of an object placed within arm reach to and across the midline. The subject moved a 3-inch diameter metal disc along a 30 x 9 x 1 inch board. The board was calibrated in inches, with the midpoint at 0 and the 1-inch spaces on either side numbered from 1 through 15. The point on the board to which the disc was pushed indicated the subject's ability to move toward or across the midline. Numbers 1 through 15 across the midline (opposite the arm in use) were considered positive, while numbers 1 through 15 on the same side as the arm in use were considered negative. Subject performance of the task during the orientation sessions indicated that the task was too simple for five subjects, who achieved maximum range on first trial. Accordingly, the researcher developed three levels for the task:

1. Reach forward to contact object and move it toward the midline.
2. Reach to the midline to contact object and move it across the midline.
3. Reach across the midline to contact object and move it around the body.

While levels one and two involve forward and lateral reaching, level three calls for some form of rotation or change in alignment of upper body parts. On the basis of performance during the orientation sessions, subjects were assigned to the task level that best suited their abilities:

Level 1: Subjects A and B

Level 2: Subjects C and D

Level 3: Subjects E, F, G, and H

(The fifth subject assigned to this task level was subsequently dropped.)

All subjects performed the arm motion task in seated position, with sufficient support used to maintain upright position for those in wheel chairs. The board and disc were placed on the subject's wheel chair tray or desk table of suitable height. Further positioning of the board and disc depended on the level of the task:

Level 1: Align point "0" with the subject's midline, using the nose as a guideline. Place the board at a distance from the subject so that the numbers are a forearm's length away, with elbow bent. Position the disc opposite (directly in front of) the arm to be used (Starting position will vary with arm position.)

Level 2: Position the board as above. Position the disc at point "0," the subject's midline.

Level 3: The board is placed at the subject's side. Align point "0" with the subject's ear and shoulder as she/he faces forward (point at which shoulder starts to rotate). Place the board at

> a distance so that numbers are a forearm's length away, with elbow bent. Position the disc forward of point "0" at a comfortable forearm reach with bent elbow (Starting position will vary with each subject.)

While the position of task equipment varied with task level, there was an attempt to maintain consistency of position for each subject.

A final consideration in task design involved the choice of arm. The decision to have subjects use the preferred arm was based on recommendation of their therapists, who maintained that the preferred arm would reflect the most change in muscle tone. An exception was made for three subjects whose nonpreferred arm was the impaired arm (Subjects C, G, and H).

## Experimental Treatment

The experimental treatment was a 5-minute music listening period, requiring subjects to sit quietly and listen to recorded music of either stimulative or sedative type. In choosing the length of the listening period, it was necessary to consider both the attention span of subjects and the time requirement for relaxation effect. The 5-minute period was judged to be brief enough to keep attention focused, but long enough to allow for changes in muscle tone state to occur. The researcher divided the subjects into two groups of four, attempting to keep the groups similar in age and degree of disability. Those in group one listened to stimulative music, and those in group two listened to sedative music, each subject hearing the same music throughout the study. The researcher recorded two 5-minute tapes of music, one consisting of three stimulative music selections, and one consisting of three sedative music selections. All selections were chosen from the classical instrumental category, which was considered less familiar to subjects than popular or folk music. Selections were chosen in consultation with a panel of three musicians, who rated each as stimulative or sedative on a scale of 1-7, with 7 being the highest rating. All selections chosen received an average rating of at least 6. The researcher used the following criteria to define stimulative and sedative music:

> Stimulative Music: Characterized by fast tempo, strongly accented rhythm, staccato type melody, predominant use of brass and percussion instruments
>
> Sedative Music: Characterized by slow tempo, smooth rhythm, legato melodic style, predominant use of stringed and wind instruments

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Sedative Music: Characterized by slow tempo, smooth rhythm, legato melodic style, predominant use of stringed and wind instruments

The pieces selected to represent stimulative and sedative music are listed below, along with metronome speed and duration of play.

Stimulative: Bizet, "March of the Torreadors" (Carmen), 126 beats/minute, 2'

Tchaikovsky, "Trepak" (Nutcracker Suite), 152 beats/minute, 1'3"

Rossini, "Finale," William Tell Overture, 160 beats/minute, 2'

Sedative: Satie, "Gymnopedie #1, 84 beats/minute, 1' 10" segment

Saint-Saens, "Le Cygne" (Carnival of the Animals), 72 beats/minute, 2'40"

Ravel, Pavane pour une Enfante Defunte, 84 beats/minute, 1'10" segment

The researcher taped the music from phonograph recordings, using a TEAC 355 stereo cassette deck. Recording levels were set at 75-100%, and volume was controlled at the end and beginning of pieces to provide smooth transitions between selections. The music selections were played to subjects on a Panasonic F4 stereo radio cassette recorder, with volume and balance controls set at midpoint and graphic equalizer set to boost the high and low ranges. The cassette player was placed opposite the subject, at the far end of the room.

During the listening period, the subject remained seated as originally positioned for the pretest tasks. The researcher sat at the far end of the room from the subject so as to avoid any communication or other contact during the listening portion of the experiment. Under the reversal condition, subjects were treated with five minutes of silence, measured with a Westclox windup stopwatch. As in the previous sessions, subjects were instructed to sit quietly for the duration of the treatment period. Table 2 presents the distribution of subjects into two experimental groups, according to task level and music treatment.

## Measurement

### Resting Posture

Videotaping was used to record subjects' resting postures before and after treatment. The tapes were reviewed by physical and occupational therapists who worked with the subjects. The postures of each subject were evaluated by the two therapists, physical and occupational, who treated that subject. A total of eight therapists participated in the review. The decision to have each subject's therapists rate the postures was based on the presumption that those experienced in treating the subjects were best qualified to evaluate them. Evaluations were recorded on rating forms, one for

Table 2. Distribution of Subjects

| Subject | Impairment | | Task Level | Music Treatment |
|---|---|---|---|---|
| | Extent | Degree | | |
| A | Quad | S | 1 | Stimulative |
| B | Quad | S | 1 | Sedative |
| C | Quad | MS | 2 | Stimulative |
| D | Di | MS | 2 | Sedative |
| E | Quad | MS | 3 | Stimulative |
| F | Di | S | 3 | Sedative |
| G | Hemi | M | 3 | Stimulative |
| H | Hemi | M | 3 | Sedative |

Code: Quad = Quadriplegic

Di = Diplegic

Hemi = Hemiplegic

S = Severe involvement

MS = Moderately severe involvement

M = Moderate involvement

Table 2. Distribution of Subjects

| Subject | Impairment | | Task Level | Music Treatment |
|---|---|---|---|---|
| | Extent | Degree | | |
| A | Quad | S | 1 | Stimulative |
| B | Quad | S | 1 | Sedative |
| C | Quad | MS | 2 | Stimulative |
| D | Di | MS | 2 | Sedative |
| E | Quad | MS | 3 | Stimulative |
| F | Di | S | 3 | Sedative |
| G | Hemi | M | 3 | Stimulative |
| H | Hemi | M | 3 | Sedative |

Code: Quad = Quadriplegic

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each subject per session. Each session evaluation included a description of the position of specific body parts before and after treatment, and an overall numerical score indicating muscle tone state, based on a 5-point rating scale. A sample rating form can be found in Appendix C.

Arm Motion Task

Scores for the arm motion task were recorded on individual session sheets for each subject. A sample session sheet for Subject A can be found in Appendix C. Each pretest and posttest score represented the point on the board which the subject attained when pushing the disc. All numbers across the midline were recorded as positive scores, while those on the other side of the midline were recorded as negative. The researcher also used individual session worksheets for noting observations of subjects' movement quality during task performance. Such observations focused on initiation, speed, and smoothness of movement, position of hand, and personal ways of using head, arms, and trunk to facilitate movement. Videotaping of task performance during sessions six, seven, and eight provided further information on movement quality.

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## Pilot Testing

The researcher tested the experimental procedure with one physically handicapped subject--spina bifida male, age 5. This provided an opportunity to practice running the equipment and recording responses, and to determine the suitability of the music treatment for school aged subjects. Because the pilot subject was not a CP, there was no indication during the testing that the arm motion task would need to be graded.

# CHAPTER IV

# RESULTS

The dependent variable, degree of muscle tone, was measured by comparing subjects' resting postures and task performances before and after treatment. Results are reported separately for each of these measures. Results for the group as a whole are presented in table form, while individual scores are reported in separate graphs for each subject. Raw data for each subject are presented in Appendix B. Sessions 3-8, which measured the dependent variable, are renumbered 1-6 for purposes of reporting results.

## Resting Posture: Main Findings

The main findings for resting posture are paired with the research questions asked at the beginning of this study. The questions and findings are listed as follows:

Question 1: Does music listening reduce excessive muscle tone in spastic cerebral palsied children, as measured after each listening session?

There was a decrease in muscle tone for the group in each music session, indicating that the music treatment had some effect on excessive muscle tone of the subjects in each session. However, use of a no-music condition produced a greater decrease in muscle tone than the music condition in Sessions 1, 3 and 6. The music treatment had a varying effect on subjects within each session. Specifically, there was a decrease in muscle tone for each subject in one or more music stimulus sessions, with six subjects experiencing a decrease in three or more sessions. There was also a decrease in tone for six subjects under the no-music condition.

<u>Question 2</u>: Does music listening reduce excessive muscle tone in spastic cerebral palsied children, as measured at the close of the treatment period?

There was a decrease in muscle tone for the group at the close of the treatment period, indicating that the music treatment had an effect on excessive muscle tone of the subjects over time. Specifically, three subjects showed an overall decrease in muscle tone, three subjects showed no change, and two subjects showed an overall increase.

<u>Question 3</u>: Does the type of music, stimulative or sedative, have an effect on muscle tone reduction?

The types of stimulative and sedative music used for treatment in this study did not make a difference in the effect of the music on the muscle tone states of the subjects.

## Resting Posture: Discussion of Findings

A numerical rating, based on a scale of 1-5, was used to represent degree of muscle tone before and after the music listening period, with 1 being the lowest degree of tone and 5 the highest. Each pretest and posttest numerical rating was averaged from the two separate ratings of two therapists who evaluated each subject. The gainscores of all subjects are based on this rating scale and presented in Table 3.

Table 3.--Gainscores for Resting Posture

| Session | 1 | 2 | 3 | 4[a] | 5 | 6 | Overall Gain |
|---|---|---|---|---|---|---|---|
| Subject A | -0.5 | 0.0 | 0.0 | +0.5 | +0.5 | +0.5 | +1.0 |
| Subject B | +1.0 | -1.0 | -1.0 | -1.0 | -1.0 | +1.0 | 0.0 |
| Subject C | -1.5 | -1.0 | -1.0 | -1.0 | -1.0 | +0.5 | +2.0 |
| Subject D | +1.5 | 0.0 | +1.0 | 0.0 | 0.0 | -1.0 | -2.5 |
| Subject E | -1.0 | -1.5 | -0.5 | -0.5 | -1.5 | -1.0 | 0.0 |
| Subject F | -0.5 | -0.5 | -0.5 | -0.5 | -0.5 | -1.0 | -0.5 |
| Subject G | +0.5 | -1.0 | 0.0 | -0.5 | -1.5 | -1.0 | -1.5 |
| Subject H | -0.5 | -1.0 | -0.5 | -0.5 | 0.0 | -0.5 | 0.0 |
| Group Score | -1.0 | -6.0 | -2.5 | -3.5 | -5.0 | -2.5 | -1.5 |

[a]Reversal condition: no music

The gainscores for resting posture are derived from repeated measures of muscle tone state in accordance with the time-series design. Each subject gainscore represents the difference between pretest and posttest ratings of degree of muscle tone, with <u>negative</u> scores indicating a <u>decrease</u> in tone, and <u>positive</u> scores indicating an <u>increase</u> in tone. Thus, if the pretest score is higher than the posttest score, a negative gainscore will result. For example, if a subject's pretest tension rating were 3.5 and posttest tension rating were 2.5, the difference between the two ratings would represent a decrease in muscle tone. This difference is expressed as a negative gainscore, -1.0. A comparison of group gainscores for Session 1 (-1.0) and Session 6 (-2.5) shows a decrease in muscle tone for the group over the treatment period (-1.5). A comparison of the group gainscore for Session 4 (-3.5) with that of Session 3 (-2.5) shows that removing the music treatment caused a change in the level of muscle tension for the group. The greatest gain for the group occurred in Sessions 2 and 5, with group gainscores of -6.0 and -5.0 indicating lower levels of muscle tone than in the other sessions. This result is in keeping with the classic pattern found in music preference research: Affective change increases up to an optimum point, often the second

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An analysis of the gainscores of Group 1 (subjects receiving stimulative music treatment) and Group 2 (subjects receiving sedative music treatment) was made using the Mann-Whitney U test. This test was selected as a measure of significance of difference between two independent groups. A value of 4, derived from the U test, was found to be associated with a probability value of .171. This value implies that the difference between the two experimental groups would be obtained 17 times out of 100 by chance alone. Therefore, there was no significant difference between the two groups as produced by two types of music treatment.

The first set of figures shows the pretest-posttest muscle tone ratings of individual subjects as measured over six sessions. Each graph shows the effect of the music listening treatment on an individual subject through a session by session comparison of pretest and posttest scores. The text accompanying each graph describes the general characteristics of each subject's posture before and after treatment, and notes special conditions which might have influenced the subject's tension rating. The descriptions of subjects' postures are based on the observations of their therapists, as recorded on rating forms for each session. These descriptions, in turn, form the basis for the numerical ratings of muscle tone state or tension.

A circle is used to identify Session 4 as a reversal session, which used a reversal (no music) condition in place of music. The reversal condition is a standard procedure used to determine if the treatment variable has an effect on the behavior of the subjects. In this case, if the music treatment caused a reduction in muscle tone, one would expect that replacement of music with a no-music condition (Session 4) would produce a rise in muscle tone, and that reintroduction of music (Session 5) would cause another reduction in muscle tone.

Subject A's tension ratings (Figure 1), with the exception of those for Session 1, indicate either the same or higher levels of muscle tone after exposure to music treatment. While the reversal condition (Session 4) resulted in an elevation of tone in the posttest, the reintroduction of music (Session 5) shows a similar elevation. Table 3 reports an overall gain of +1.0 for Subject A, indicating an increase in muscle tone at the close of the treatment period.

When seated in resting position, Subject A displayed high muscle tone through extension of the arms (at times off the wheel chair tray), clenching of the fingers, rolling of the eyes, and a strong symmetrical

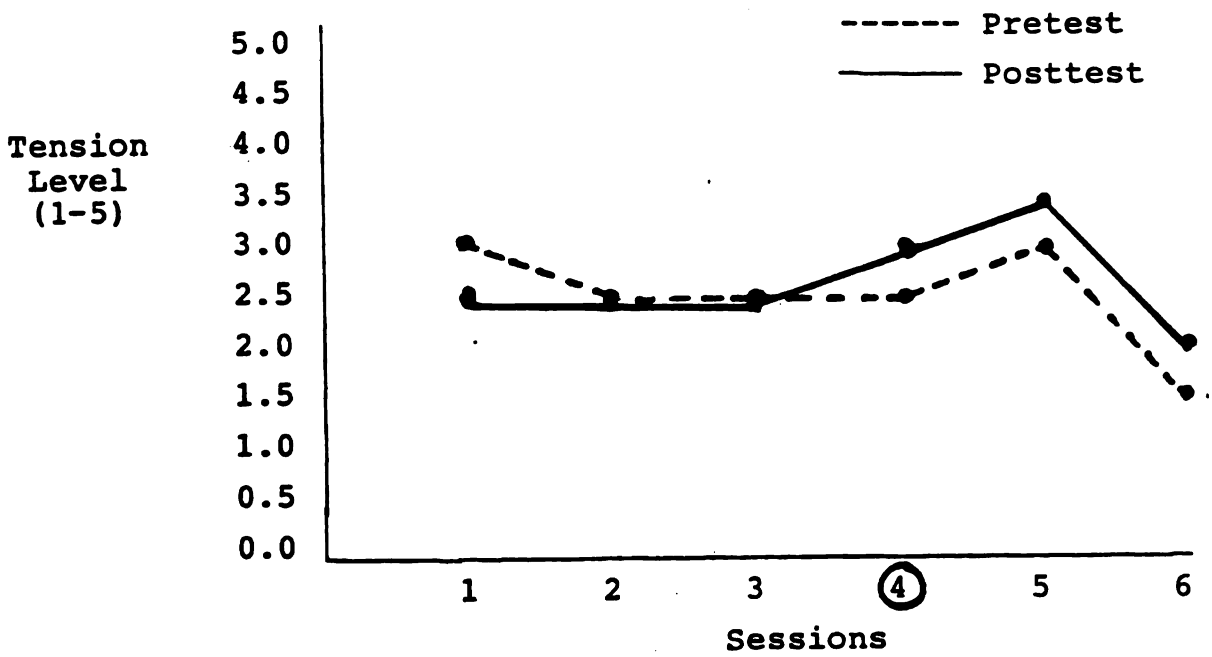


Figure 1. Pretest-posttest ratings for resting posture: Subject A

tonic neck reflex pattern involving backward head extension and forward arm extension, alternating at times with forward flexion of the head and arms. A decrease in muscle tone was marked by repositioning of the head at midline, focusing of eyes, resting of arms on tray with elbows flexed, opening of hands, and extension of fingers. Significant degree of relaxation in all parts of the body was observed in the pretest and posttest postures for Session 6.

Subject B's tension ratings (Figure 2) show a consistency in pretest levels, contrasted with a variation in posttest levels. While the no-music condition (Session 4) had the same effect as the music

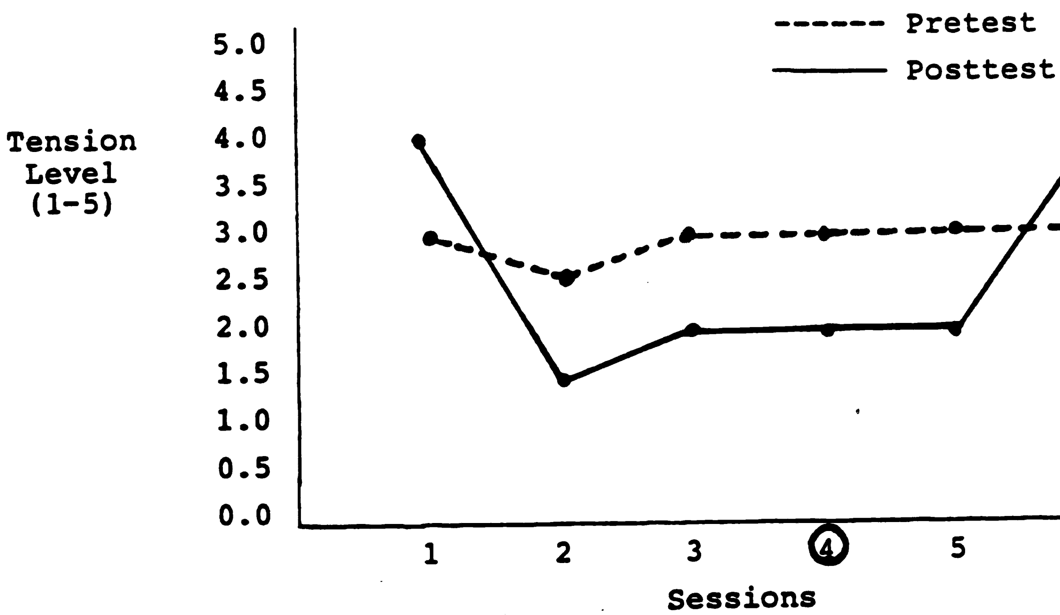


Figure 2. Pretest-posttest ratings for resting posture: Subject B

treatment in adjacent sessions 3 and 5, the drop in tension levels in Sessions 2 through 5 suggests that the subject did respond to treatment per se. The rise in tension level in Session 6 marks a reversal of the trend in the previous sessions. While Table 3 reports a gainscore of 0.0, indicating that there was no change in Subject B's muscle tone state at the close of the treatment period, this conclusion may be qualified by data from Figure 2, showing a definite decrease in tension levels in Sessions 2 through 5.

When seated in resting position, Subject B manifested fluctuating tone, indicated by involuntary movements of the head and arms, which were accompanied by increasing movement of the eyes, mouth, and fingers. There was a recurrence of rotary head movement, marked by changes between erect, tilted, and dropped positions of the head. A decrease in movement--of head, arms, hands--was indicative of a decrease in tone. Because the subject tended towards involuntary movement even when appearing to relax, it would be useful to count the number of movements in a given pretest-posttest period when judging subtle changes in posture. Subject B's posture at the point of lowest tension (Session 2, posttest) was characterized by dropping of the head, shoulders, and arms, the latter resting at the sides of the body. In contrast, posture at a point of high tension (Session 6, posttest) was characterized by raising of the head and extension of the arms and fingers. Because of postural changes arising from continuous movement, evaluation of Subject B's muscle tone state was difficult.

Subject C's tension ratings (Figure 3) show a consistency in levels for both pretest and posttest, with a similar drop in posttest tension levels for all sessions except the last. Although the posttest level exceeded the pretest in Session 6, the difference between them is small, with the posttest rating the same as all previous pretest ratings. The reversal condition had no effect on posttest tension levels, which remained the

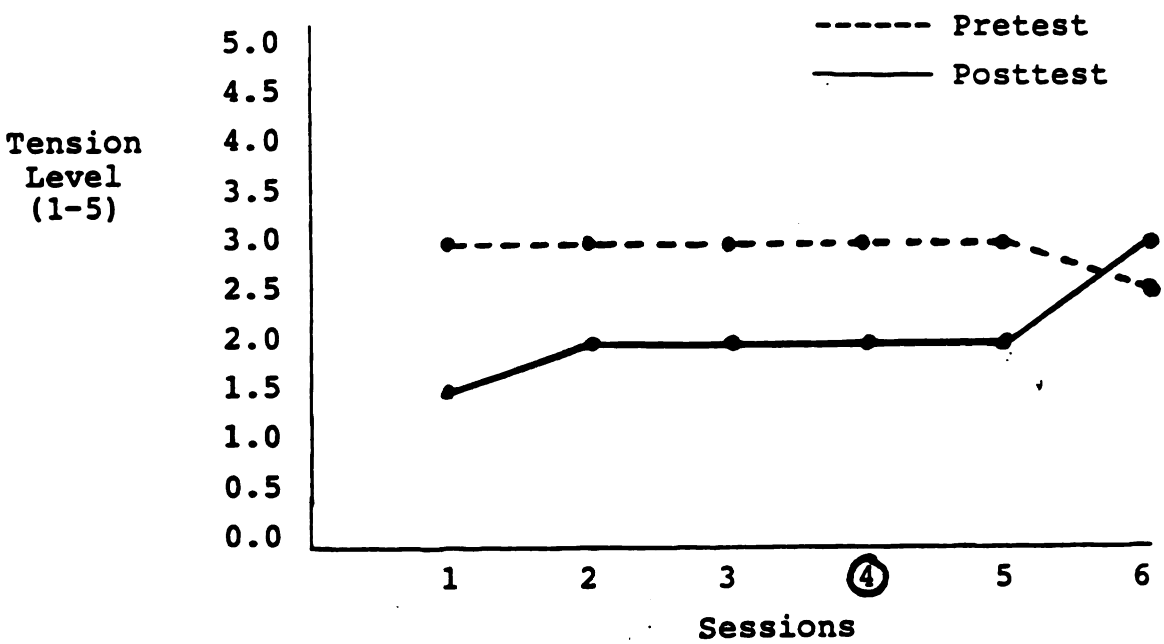


Figure 3. Pretest-posttest ratings for resting posture: Subject C

same for Sessions 3, 4, and 5. While Table 3 reports a tension increase of +2 for Subject C at the close of the treatment period, Figure 3 calls attention to this subject's positive response to treatment during the course of the study.

When seated in resting position, Subject C presented a moderate tone state through erect posture, characterized by midline head position and alignment of the head, shoulders, and trunk. Other indications of this tone state were finger movements, arm flexion, and a smiling expression. The subject showed a decrease in tone through a change of posture and affect, which involved dropping the head, slumping the shoulders, relaxing the right arm, resting the left (contracted) arm on the wheel chair tray, decreasing hand movement, yawning, and losing visual focus. Changes indicating decreased tone were particularly noticeable in posttests of Sessions 1, 3, and 5.

The ratings for Subject D (Figure 4) show only one posttest drop in tension level, Session 6, with

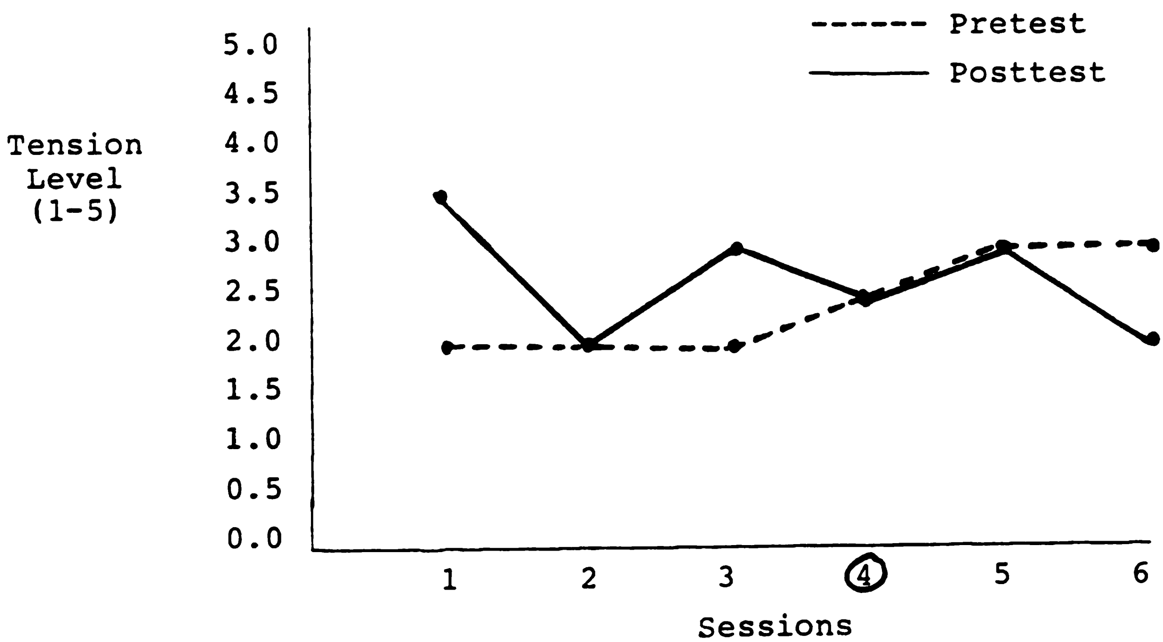


Figure 4. Pretest-posttest ratings for resting posture: Subject D

levels in other sessions exceeding the pretest or remaining the same. While the pretest rate shows a gradual increase over time, the posttest rate varies erratically. A posttest drop in tension in Session 2, from the level in Session 1, suggests an increase in affective change, which characteristically occurs in the second in a series of listening sessions. However, there was no drop in tension with the reintroduction of music in Session 5, a response one would expect after an intervening interval. Neither the reversal condition (Session 4) nor the reintroduction of the music stimulus (Session 5) had an effect on the subject's tension level, which remained the same as the pretest level in both sessions. While Subject D's session to session responses do not point to a lowering of tension level with treatment, her gainscore of -2.5 (Figure 3) indicates a lower tension level at the close of the treatment period. Therefore, the results as reported in Figure 4 serve to qualify those in Table 3.

When seated in resting position, Subject D generally manifested a low muscle tone state, indicated by dropped head, droopy mouth, tilted trunk (leaning heavily to side), and limp hands. Pretest tension ratings of 2-2.5 for Sessions 1-4 reflect observations of the subject in this low tone state. A change in the arms, from "high toned" to "more normal," was noted after music in Session 6, the only session in which the posttest rating dropped. Slight changes in posture indicating increased muscle tone were noted in the posttests of Sessions 1, 3, and 5. These included increased head control, more upright position of trunk, and flexion of arms.

Subject E's tension ratings (Figure 5) show a drop in tension level for all sessions. The greatest

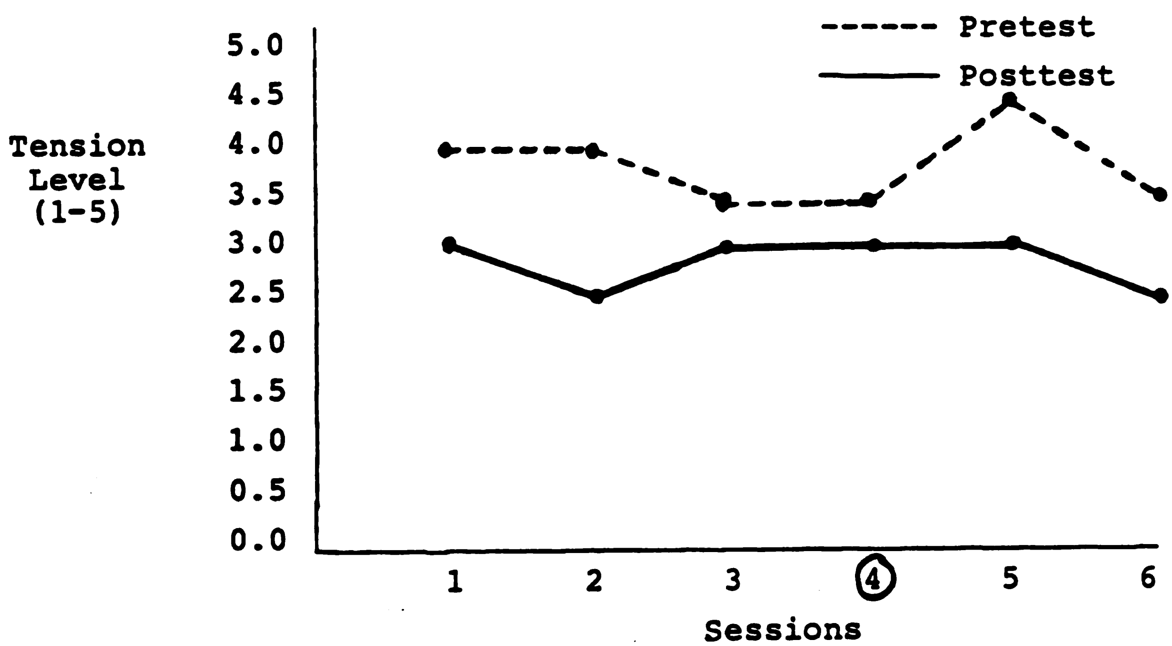


Figure 5. Pretest-posttest ratings for resting posture: Subject E

decrease was in Sessions 2 and 5, which represent points in a listening series experiment where change in response to treatment is most likely to occur. The no-music condition (Session 4) had the same effect as the music condition in Session 3, with pretest-posttest levels remaining the same. In Session 5, however, the reintroduction of the music stimulus was followed by a marked decrease (3.0) from the pretest tension level (4.5), illustrating an indirect effect of the reversal condition on this subject. Subject E's overall gainscore of 0.0 indicates no change in muscle tone at the close of the treatment period. This result conflicts with the data from Figure 5, which points up a decrease in muscle tone, as measured in each session.

The subject's high resting tone, reflected in the pretest ratings of 4.0, 3.5, and 4.5 (Figure 5) was manifested by stacked (arched) head, tight shoulders, rigid or extended trunk, fisted hands, and extension of arms and legs. Postural changes indicating a lower tone included better head control (less stacking), more shoulder and trunk flexion, relaxation of arms, opening of hands, and flexion of legs. Postural changes revealing a decrease in tone were easiest to observe in Sessions 2 and 5, when the subject was seated in an electric "car," which lacked the supports of his wheel chair. While this unavoidable change of positioning interfered with control of an important variable, it provided an opportunity to evaluate the subject's postural changes when not restricted by chair supports.

Subject F's tension ratings (Figure 6) show a slight decrease in muscle tone for Sessions 1 through 5. There is a consistent relationship between pretest and posttest levels until Session 6, where the posttest

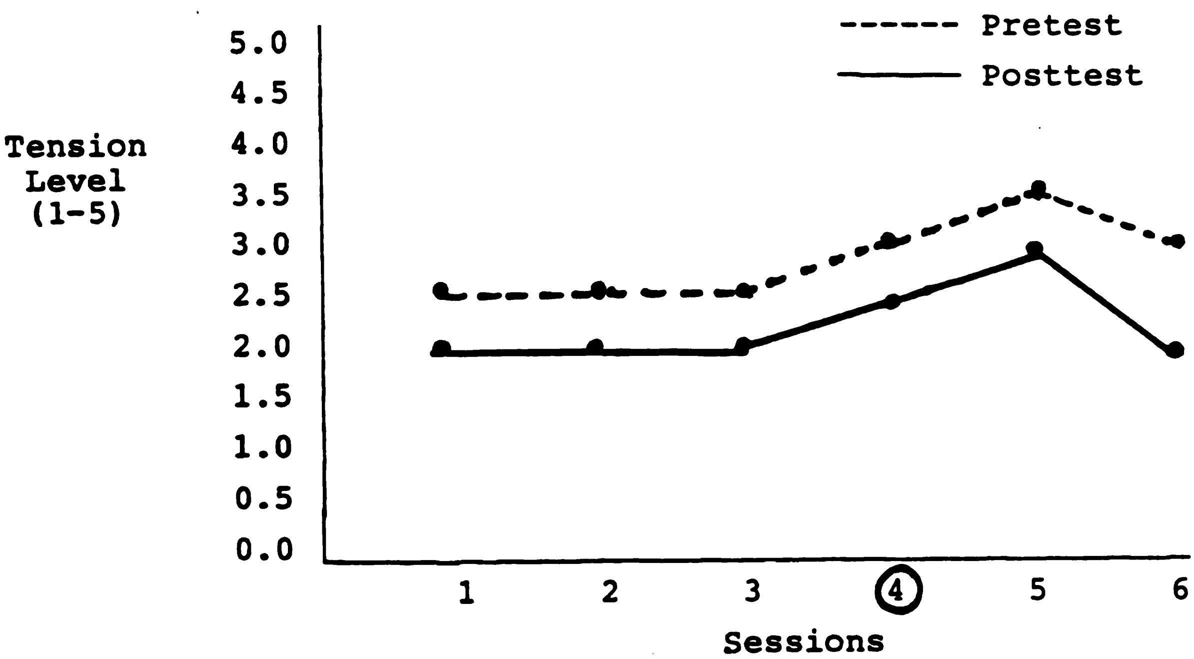


Figure 6. Pretest-posttest ratings for resting posture: Subject F

tension level drops further. Removal of the music treatment in Session 4 had no effect on the relationship of pretest and posttest tension levels. The subject's overall gainscore of -.5 (Table 3) represents a small decrease in muscle tone at the close of the treatment period, and confirms the results noted above.

When seated in resting position, Subject F manifested low to moderate tone, with posture generally characterized by poor trunk stability involving forward flexion or leaning to the side. Postural changes from pretest to posttest were slight, with Session 6 the only session for which both observers recorded a decrease in muscle tone. Changes in muscle tone for Subject F were most easily observed through change in leg position and facial expression. Adduction of the legs indicated increased tone, while abduction signified decreased tone. The subject's sleepy expression in the posttest pictures of Sessions 2 and 3 (nodding head, yawning, glazed eyes) implied a relaxation of tone as a response to music treatment. In most of the sessions, this decreased tone state resulted in a general deterioration of the subject's posture.

Subject G's tension ratings (Figure 7) show a consistency in pretest levels, contrasted with a

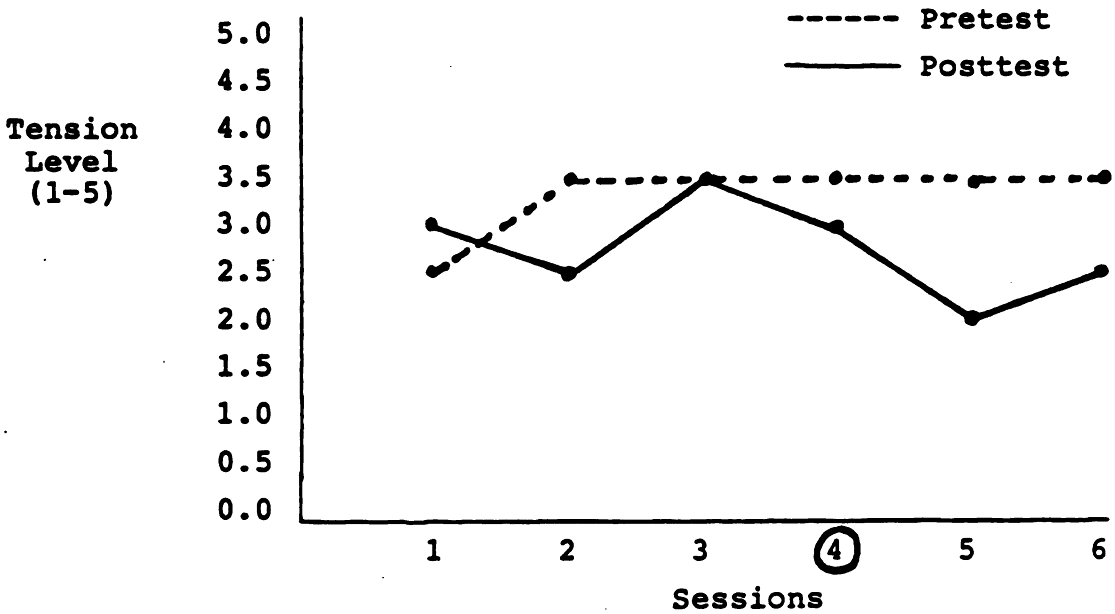


Figure 7. Pretest-posttest ratings for resting posture: Subject G

variation in posttest levels. Posttest decreases in tension occurred in three out of five music stimulus sessions, with the greatest decrease in response to the reintroduction of music in Session 5. While the no-music condition in Session 4 caused a slight decrease in tension, the music treatment produced a stronger response in Sessions 2, 5, and 6. The subject's overall gainscore of -1.5 (Table 3) indicates a decrease in muscle tone at the close of the treatment period.

When seated in resting position, Subject G tended toward excessive, spontaneous movement, which resulted in a general increase in tone. Movement most often took the form of hand tapping and leg swinging, or when more generalized, was described as "fidgeting." At these times, higher tone was observed in the involved (right) side of the body: shoulder elevated, arm more flexed, fingers clenched, hands pressed together. Movement continued into the music listening period, becoming more intense and involving the arms, head, and shoulders, as well as the legs. Movement tended to decrease in the posttest, becoming less intense or subsiding altogether. The subject was described as sitting more quietly, with shoulders in alignment, right arm relaxed, and right hand resting on chair or in lap. Contrast between the subject's pretest and posttest postures was particularly noted in Session 5, which marked the greatest decrease in tone: "wound up" during the pretest, and "considerably more quiet," "more calm and collected" during the posttest.

Subject H's tension ratings (Figure 8) show a decrease in posttest level for all sessions, except

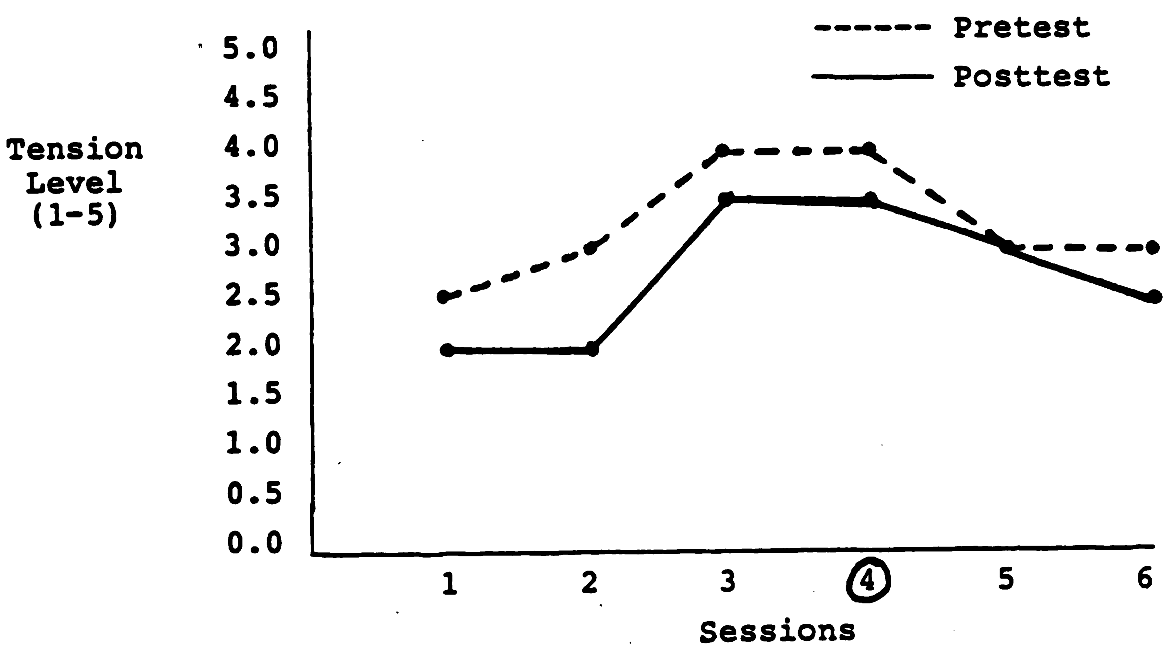


Figure 8. Pretest-posttest ratings for resting posture: Subject H

Session 5. A stronger response in Session 2 suggests an increase in affective change, which characteristically occurs in the second of a series of listening sessions. The no-music condition in Session 4 had the same effect as the music condition in the previous session, with pretest and posttest tension levels remaining the same. Furthermore, the reintroduction of the music stimulus in Session 5 produced no change in the subject. Table 3 reports a gainscore of 0.0, indicating no change in muscle tone state for Subject H at the close of the treatment period.

When seated in resting position, Subject H manifested varying states of muscular tension, accompanied by varying degrees of attentiveness. Moderate to high tone was indicated by facial movements (twisting of mouth, frowning), hand and finger movements, crossing of legs, and folding of arms tightly against the body. Decrease in tone was indicated by postural and affective changes, which included slumping shoulders, bobbing head, uncrossed legs, limp hands, slack mouth, and glazed or downcast eyes. During the posttest of Session 2, one of the lowest points of tension, the subject was observed leaning against a wall cupboard in total body flexion. As the study progressed, Subject H's behavior was marked by increased distractibility. Typical behaviors included playing with fingers, scratching head, and looking around the room. While an increase in tone was associated with a decrease in attentiveness, it brought about an overall improvement in posture, as shown in an erect position of trunk and shoulders and midline position of head.

Arm Motion Task: Main Findings

The main findings for the arm motion task are paired with the research questions asked at the beginning of this study. The questions and findings are listed as follows:

Finding 1: Does music listening reduce excessive muscle tone in spastic cerebral palsied children, as measured after each listening session?

There was an increase in range of motion in task performance for the group in each session. This result suggests a decrease in muscle tone in response to music treatment. While use of a no-music condition resulted in improved task performance, group performance gainscores were higher in four out of five music sessions. The music treatment had a varying effect on subjects within each session. All but one subject showed increased range of motion in three or more music stimulus sessions. There was also increased range of motion for four subjects under the no-music condition.

Finding 2: Does music listening reduce excessive muscle tone in spastic cerebral palsied children, as measured at the close of the treatment period?

There was a decrease in range of motion for the group at the close of the treatment period, indicating an increase in muscle tone over time. Specifically, two subjects showed an overall increase in range of motion,

and six subjects showed an overall decrease in range of motion.

<u>Finding 3</u>: Does the type of music, stimulative or sedative, have an effect on muscle tone reduction?

The type of stimulative and sedative music used for treatment in this study did not make a difference in the effect of the music on the muscle tone states of the subjects.

## <u>Arm Motion Task: Discussion of Findings</u>

Scores for the arm motion task indicated ability to move toward, across, or around the midline. A numerical score representing distance in inches from the midline of the subject was recorded for each pretest and posttest performance. Increased range of motion in task performance indicated a decrease in muscle tone. The gainscores of all subjects are based on these task scores and are presented in Table 4.

The gainscores for the arm motion task are derived from repeated measures of muscle tone state in accordance with the time-series design. Each subject gainscore represents the difference between pretest and posttest range of motion, with <u>positive</u> scores indicating a <u>decrease</u> in muscle tone, and <u>negative</u> scores indicating an <u>increase</u> in muscle tone. A comparison of group

and six subjects showed an overall decrease in range of motion.

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The type of stimulative and sedative music used for treatment in this study did not make a difference in the effect of the music on the muscle tone states of the subjects.

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Table 4. Gainscores for Arm Motion Task

| Session | 1 | 2 | 3 | 4[a] | 5 | 6 | Overall Gain |
|---|---|---|---|---|---|---|---|
| Subject A | +2.0 | +2.0 | -1.0 | +2.0 | +1.0 | +0.0 | -2.0 |
| Subject B | -0.5 | -1.0 | 0.0 | 0.0 | -1.0 | -4.0 | -3.5 |
| Subject C | +2.0 | +1.0 | +2.0 | +1.0 | +1.0 | +1.0 | -1.0 |
| Subject D | +0.5 | 0.0 | +1.0 | -2.0 | +2.0 | 0.0 | -0.5 |
| Subject E | +1.5 | +1.0 | +1.5 | 0.0 | +3.0 | +1.0 | -0.5 |
| Subject F | +4.0 | +4.0 | +0.5 | +1.0 | -2.0 | +7.0 | +3.0 |
| Subject G | 0.0 | +4.0 | +1.0 | 0.0 | 0.0 | +1.0 | +1.0 |
| Subject H | +5.5 | +2.0 | -2.5 | +1.5 | +3.0 | +4.5 | -1.0 |
| Group Score | +15.0 | +13.0 | +2.5 | +3.5 | +7.0 | +10.5 | -4.5 |

[a]Reversal condition: no music

gainscores for Session 1 (15.0) and Session 6 (10.5) shows a decrease in range of motion (-4.5) and, therefore, an increase in muscle tone for the group over the treatment period. A comparison of the group gainscore for Session 4 (3.5) with that of Session 3 (2.5) shows that removing the music treatment in Session 4 produced a slight improvement in task performance. However, a comparison of the results of Session 4 with those of other music stimulus sessions indicates that subjects performed better under the music stimulus condition. The increase in group gainscores occurring after Session 4 suggests an increase in affective change with the reintroduction of music in Session 5.

An analysis of the gainscores of Group 1 (subjects receiving stimulative music treatment) and Group 2 (subjects receiving sedative music treatment) was made using the Mann-Whitney U test. This test was selected as a measure of significance of difference between two independent groups. A value of 7, derived from the U test, was found to be associated with a probability value of .443. This value implies that the difference between the two experimental groups would be obtained 44 times out of 100 by chance alone. Therefore, there was no significant difference between the two groups as produced by two types of music treatment.

The second set of figures shows the pretest-posttest task scores of individual subjects as measured over six sessions. Numbers on the vertical axis of the graphs differ according to task level. The text accompanying each graph describes the movement pattern and movement quality of subjects as they performed the task, and notes special conditions which might have influenced task performance. Descriptions of task performance are based on session observations of the researcher and videotape review of raters. In this textual description, movement pattern refers to the position of the active parts of the body during task performance: for example, flexion of arms, extension of trunk, rotation of trunk. Movement quality refers to smoothness, speed, control of direction, and immediacy of response.

The first two figures present data for subjects performing the arm motion task at level 1. The level 1 task required subjects to reach forward to contact an object and move it toward the midline. Movement from negative to positive numbers indicates an increase in range of motion and a decrease in muscle tone for subjects performing at level 1.

Subject A's posttest scores (Figure 9) improved in all but Sessions 3 and 6. The best performances occurred in Sessions 2, 4, and 5, where the subject succeeded in crossing the midline. Performance improved under the no-music condition in Session 4, as contrasted with a Session 3 drop in posttest score. The subject's overall gainscore of -2 indicates no decrease in muscle tone (as measured by range of motion) at the close of the treatment period. This result, however, does not reflect the high posttest scores in Sessions 2, 4, and 5.

The subject's use of abnormal reflex patterning helped to drive movement across the midline. The initiation of movement triggered either the ATNR or STNR postural reflexes, which involved extension of the head performance: for example, flexion of arms, extension of trunk, rotation of trunk. Movement quality refers to smoothness, speed, control of direction, and immediacy of response.

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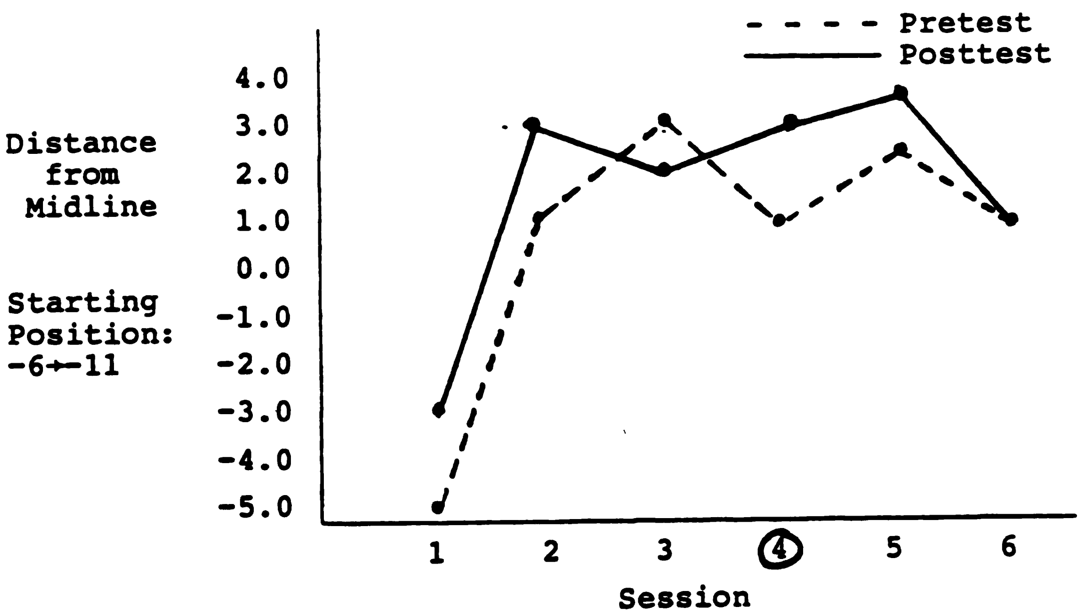


Figure 9. Pretest-posttest scores for arm motion task: Subject A

and arms, enabling movement necessary for the task. This reflex pattern was at its strongest during the posttest of Session 5. With head extended back and turned to the side and mouth wide open, the subject gave firm pushes to the object with extended fingers of the right hand, while the left hand moved continuously. While movement of this type is associated with high muscle tone, there were qualities in the subject's movement that suggested decreased tone. These were immediacy of response to movement cue and smoothness of lateral arm movement. The high degree of effort, which the subject used in Session 5 to attain her highest score, may have been particularly effective because of prior relaxation during treatment. Decrease in tone during task performance was also implied by a change in the subject's movement quality in Session 6. Using abnormal reflex patterning, she achieved the same score in the posttest as in the pretest, but with less effort. This was indicated by the flexed position of the head, mouth closure, and decrease in left arm movement.

Subject B's posttest scores (Figure 10) were below or the same as the pretest, with lowest scores of

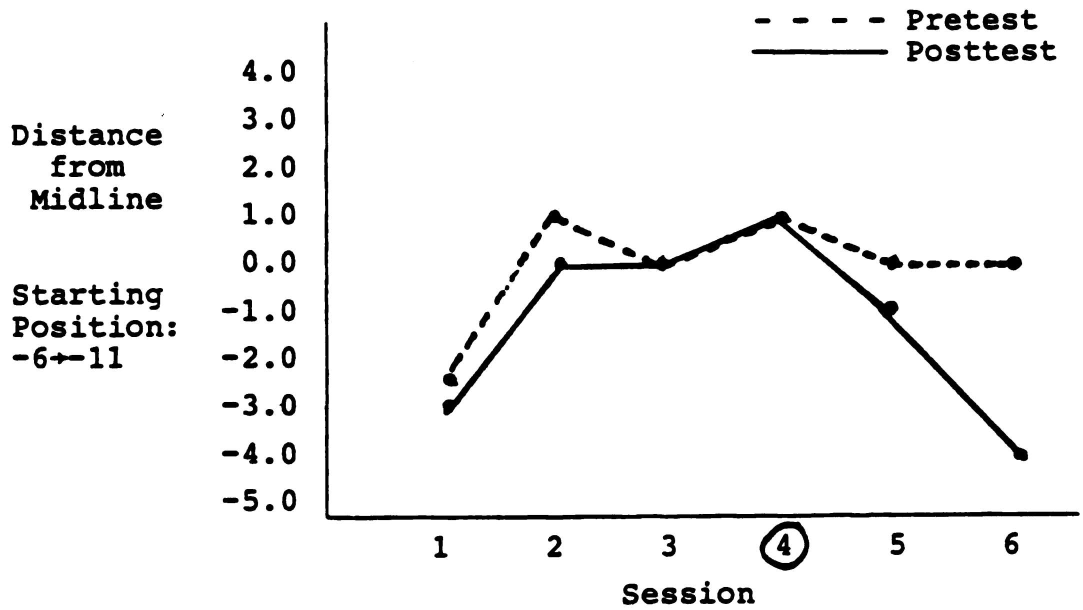


Figure 10. Pretest-posttest scores for arm motion task: Subject B

all occurring in posttest of Sessions 1 and 6. Performance improved under the no-music condition (Session 4), with the subject attaining her highest posttest score. The overall gainscore (Table 4) of -3.5 indicates an increase in muscle tone (as measured by range of motion) at the close of the treatment period.

Because of severe involvement, Subject B's success in reaching the midline (point 0) was, in itself, an accomplishment. Generally, the subject had more control of movement at the side of the body, so that reaching forward with the arm was much more feasible than moving it toward the midline. Unable to control lateral movement, she tended to push the object away from or toward the body. Movement to the midline resulted in a tightening of muscles, causing an involuntary reversal of movement. The subject's best posttest performance (Session 4) was characterized by strong lateral movement, with control of the object secured by open hand and thumb. In general, a strong STNR pattern, in which flexion of the head produced flexion of the arms, prevented effective movement during task performance. This was particularly so in the posttest of Session 6, where there was no extension of arms to push the object. A decrease in Subject B's movement skill was seen as an indicator of decreased muscle tone. While the "swiping away" arm movement used in the posttest of Session 5 produced a lowered score, it represented a positive result in that it denoted a decrease in tension. In the case of Subject B, performance of skilled movement patterns would require an increase, rather than a decrease, in muscle tone.

The next two figures present data for subjects performing the arm motion task at level 2. The level 2 task required subjects to reach to the midline to contact an object, and move it across the midline. Movement from lower to higher positive numbers indicates an increase in range of motion and a decrease in muscle tone for subjects performing at level 2.

Subject C's posttest scores (Figure 11) exceeded the pretest in all sessions, with higher scores in the first half of the experiment. While the posttest score dropped under the no-music condition (Session 4), it remained at the same level for Sessions 5 and 6 under the music condition. An overall gainscore of -1 indicates increased muscle tone (as measured by range of motion) at the close of the treatment period. This result must be qualified, however, by examining the data from individual sessions.

Subject C performed the task with her involved arm, which was seldom used for activity. In a state of contracture, the arm remained in flexed position, with wrist flexed and fingers limp. The subject used the

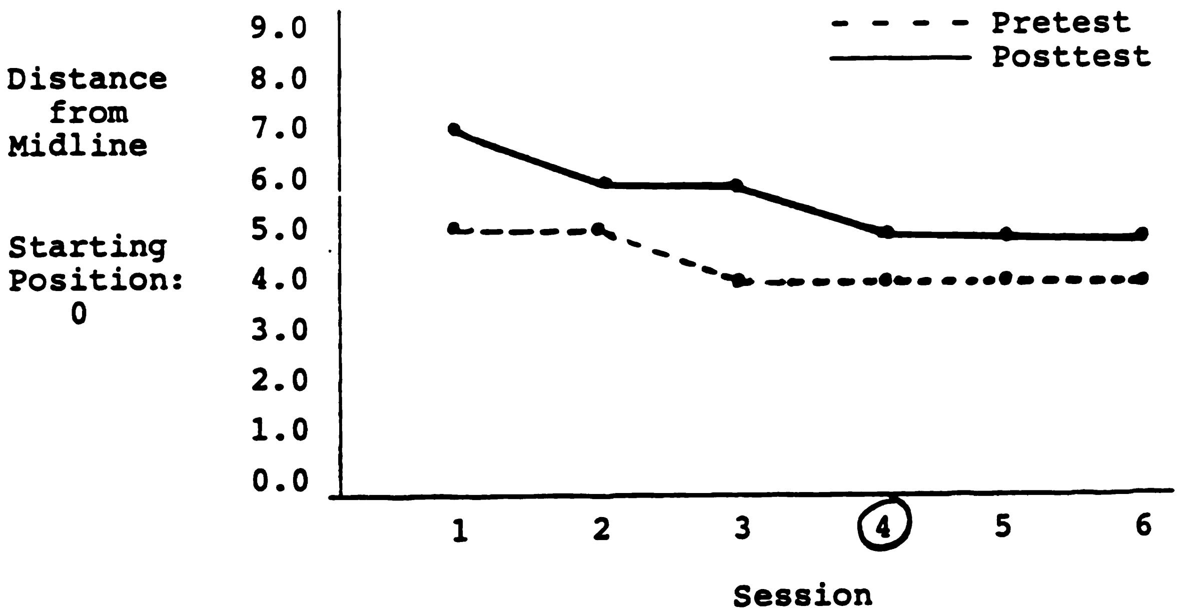


Figure 11. Pretest-Posttest scores for arm motion task: Subject C

shoulder to drive the movement, contacting the object with the fingertips and dragging the elbow behind. Movement was generally slow and smooth, with movement reversal (pretests of Sessions 3, 5, and 6, and posttest of session 6) indicating a tightening of muscles as the subject attained maximum range. Elevation of the elbow in the posttest of Session 6 denoted greater effort and possibly brought about a high score. While improved quality of movement (smoothness, control of direction) led to higher scores in the posttests of Sessions 2 and 3, it resulted in lower scores in the pretests of 5 and 6. One observer equated the decreased movement skill observed in the posttests of Sessions 5 and 6 with a decrease in tone. This would mean that the subject's improved posttest performance in these sessions was related to a decrease in muscle tone, as reflected by a decrease in movement quality. This relationship between task performance, muscle tone state, and movement quality is complex, and will be further discussed in the next chapter of this study.

Subject D's posttest scores (Figure 12) varied widely in comparison with scores for pretests. The

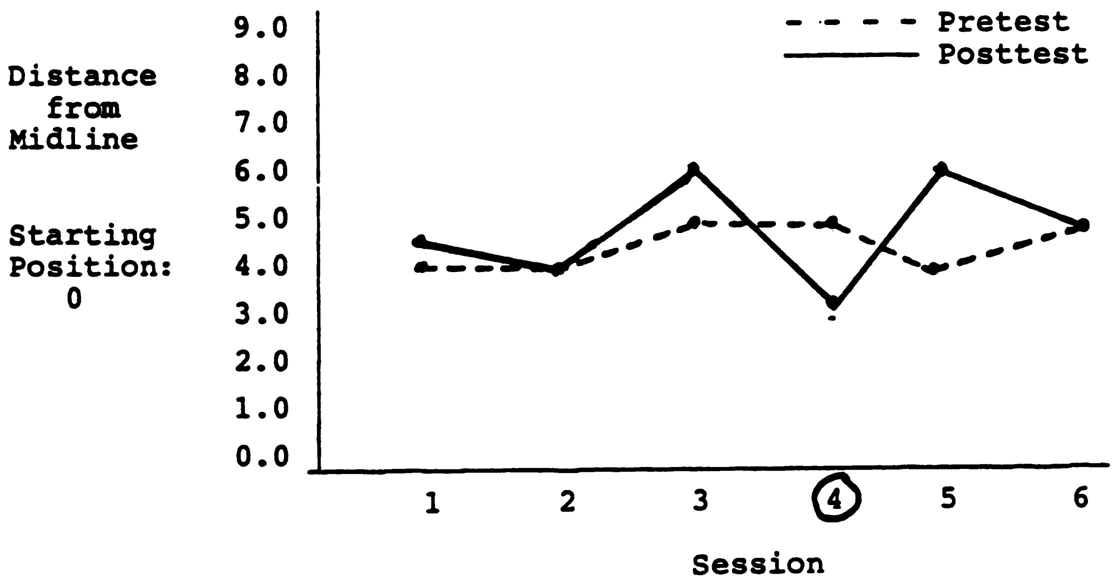


Figure 12. Pretest-posttest scores for arm motion task: Subject D

highest posttest scores occurred in Sessions 3 and 5, which preceded and followed the no-music session. Removal of the music condition (Session 4) produced the only drop in posttest score below pretest level. The subject's overall gainscore of -.5 (Figure 4) indicates a small increase in muscle tone (as measured by range of motion) at the close of the treatment period.

The subject used short pushes to move the object, and tended to direct the movement out from the body at an angle rather than straight across the midline. A "butterfly" support used to promote better posture was not adequate in overcoming forward flexion, so that Subject D's seated position (leaning forward) was not optimal for task performance. Improvement in movement quality (greater smoothness, more control of midline direction) was observed during the posttest of Sessions 3 and 5, where the subject attained her highest scores. Since jerky movement was an indication of increased tone for Subject D, it is assumed that the smoother, more controlled movement observed during specific posttests involved a reduction in muscle tone at these particular times.

The following four figures present data for subjects performing the arm motion task at level 3. The level 3 task required subjects to reach across the midline to contact an object and move it around the body. This task called for some form of rotation or change in alignment of upper body parts. Movement from lower to higher positive numbers indicates an increase in range of only drop in posttest score below pretest level. The subject's overall gainscore of -.5 (Figure 4) indicates a small increase in muscle tone (as measured by range of motion) at the close of the treatment period.

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Subject E's posttest scores (Figure 13) improved in all sessions, except Session 4. Use of the no-music condition in Session 4 had no effect on posttest performance scores, which remained the same as in the pretest. The subject attained his highest score of 14 in Session 5, with the reintroduction of the music stimulus. This result was influenced, in part, by a seating change, facilitating greater range of motion; however, there was increased range from pretest to posttest within Session 5. A gainscore of -.5 (Table 4) indicates that there was a slight increase in muscle tone (as measured by range of motion) at the close of the treatment period.

Subject E performed the task using trunk flexion or extension to compensate for lack of independent trunk rotation. His performance must be interpreted in the light of seating changes which occurred during the course of the experiment. In sessions 1, 3, 4, and 6, the subject was seated in a wheel chair. Wheel chair supports for trunk and shoulders stabilized him for movement, but inhibited rotation, causing the subject to flex his body to perform the task. Shoulder supports were repositioned in Session 6 to allow for greater freedom of movement. During Session 6, the subject's posttest movement showed minimal shoulder rotation and was smoother in quality. Observers noted that he

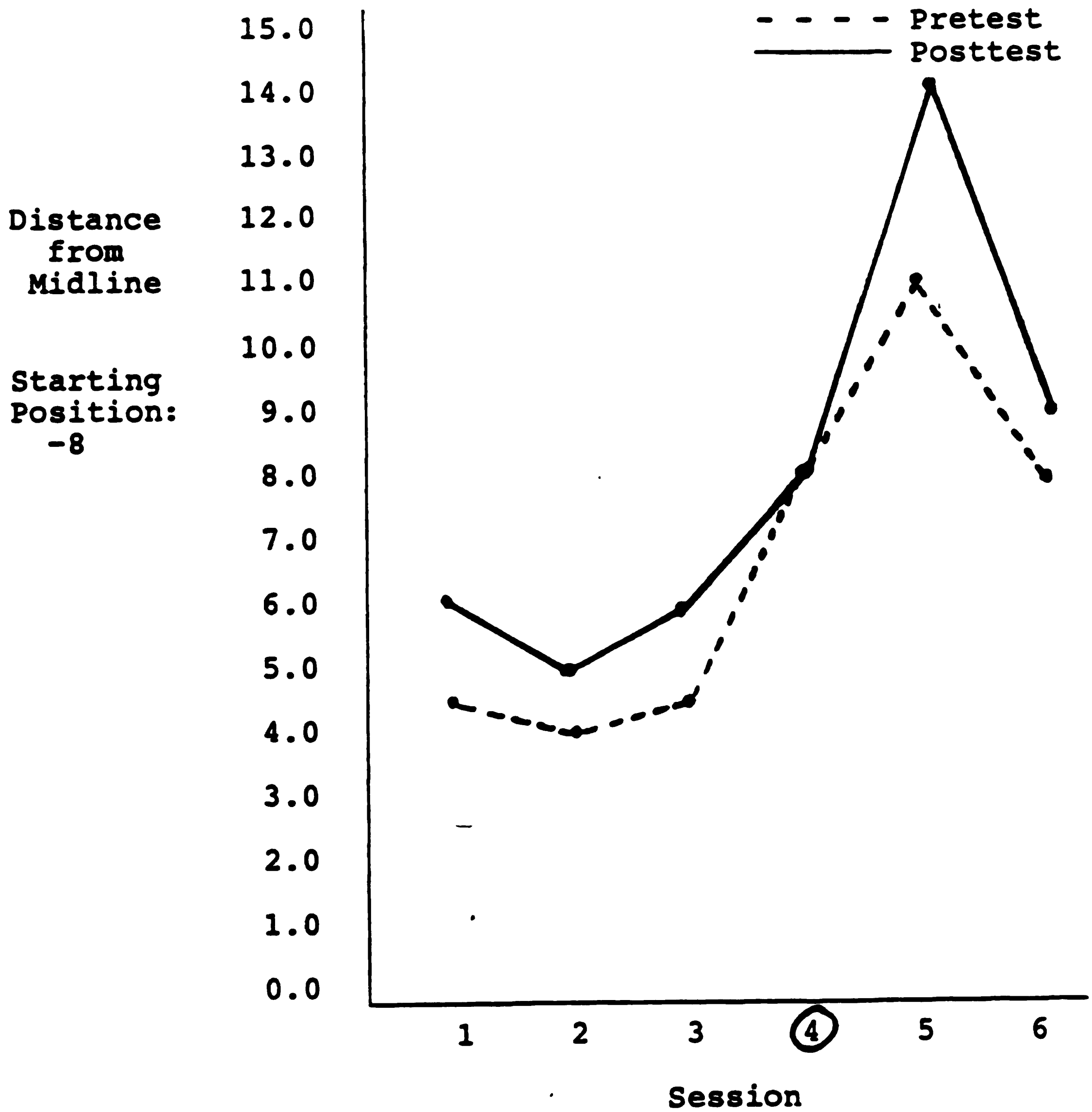


Figure 13. Pretest-posttest scores for arm motion task: Subject E

appeared more relaxed and accomplished the task more easily. Although the subject's posttest score improved only slightly, his movement pattern and quality denoted a decrease in muscular tension. In sessions 2 and 5, the subject was seated in an electric "car," which permitted more freedom of movement, but gave no support. Movement in this position involved lateral trunk flexion and total body extension. The greater effort required for these compensatory movements brought about an increase in tone during task performance. Although seating position influenced Subject E's muscle tone state, as well as his movement quality and pattern, it did not interfere with range of motion, which improved in five out of six sessions.

Subject F's scores (Figure 14) vary widely for both pretest and posttest. While posttest scores improved in all sessions, except Session 5, the relationship between pretest and posttest scores shows no consistent pattern. Removal of the music stimulus in Session 4 caused a slight improvement in performance, while the reintroduction of music in Session 5 was followed by a drop in performance. The subject's overall gainscore of +3 (Table 4) indicates a decrease in muscle tone (as measured by range of motion) at the close of the

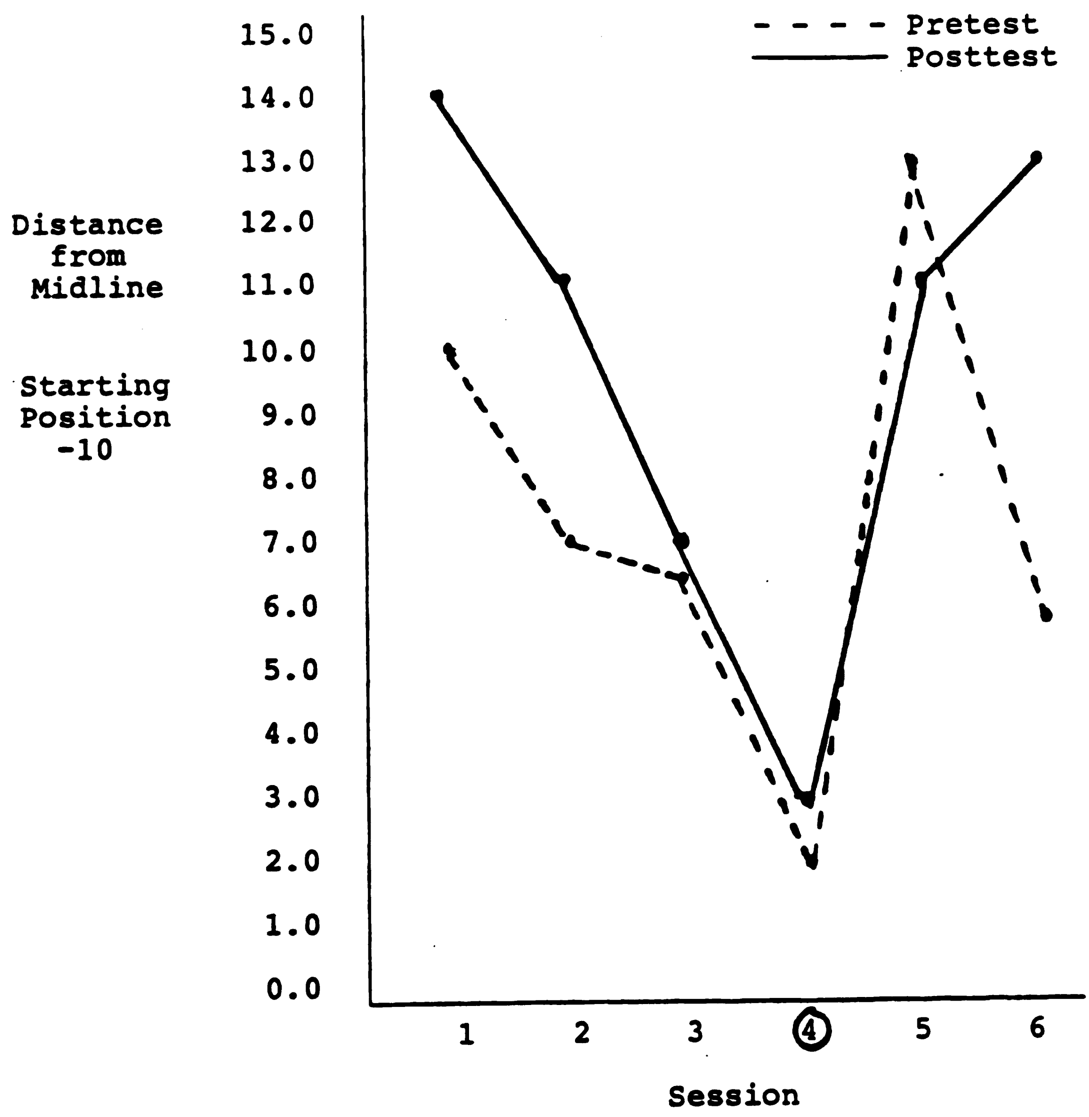


Figure 14. Pretest-postest scores for arm motion task: Subject F

treatment period. The marked increase in posttest score in Session 6 is responsible for this result.

Variation in subject F's performance scores may be partially explained by changes in behavior over the course of the experiment. Lower scores reflect a lack of effort, possibly due to greater fatigue on certain days, and a decrease in attentiveness after the initial sessions. Lacking independent rotation, the subject used compensating movements to do the task. These involved lateral trunk flexion followed by neck extension, and occasionally, elevation of the hips. Slight trunk rotation, however, was observed in the posttest of Session 6, where movement was noted to be smoother and faster. When correlated with a posttest drop in tension (Figure 6, Session 6), this increased range of motion suggests a positive response to treatment.

Subject G's posttest scores (Figure 15) were the same as the pretest or higher. All scores, with the exception of the pretest in Session 2, fell within a narrow range of 13-15. While the no-music condition (Session 4) had no effect on the posttest score, neither did the reintroduction of music in Session 5. A gainscore of +1 (Table 4) indicates a decrease in muscle tone (as measured by range of motion) at the close of the treatment period.

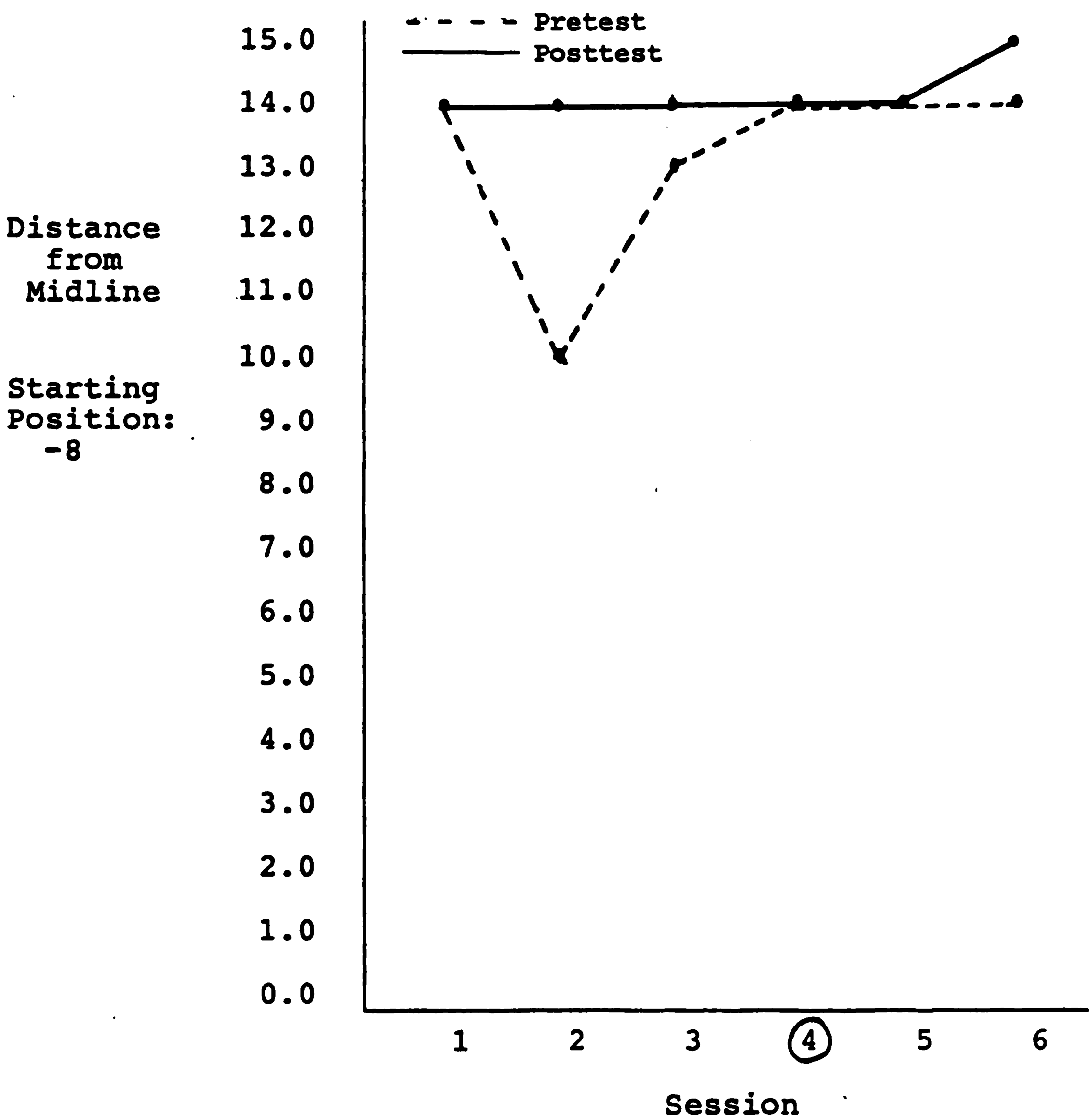


Figure 15. Pretest-posttest scores for arm motion task: Subject G

Subject G used a pattern of upper trunk rotation and lateral trunk flexion to perform the task. Better trunk rotation (Session 5 posttest, Session 6 pretest and posttest) and increased elbow extension in the involved arm (Session 4 and 6, posttests) indicated decrease in muscle tone. The subject's tendency to pause during movement decreased in the posttests, where movement was smoother and often faster. Increased fluidity in movement meant decreased tone in the involved side of the body. For Subject G, it was improvement in movement pattern and quality, rather than scores, that indicated reduction in muscle tone.

Subject H's posttest scores (Figure 16) improved in all sessions, except Session 3. Both pretest and posttest scores varied throughout, and showed little consistency in their relationship. The subject scored higher under the no-music condition (Session 4) than in the preceding and following sessions. An overall gainscore of -1.0 indicates an increase in muscle tone (as measured by range of motion) at the close of the treatment period. This result, however, may be qualified by Figure 16, which shows substantial improvement in posttest performance for Sessions 5 and 6.

Subject H performed the task with her involved arm in flexed position. She used little or no rotation,

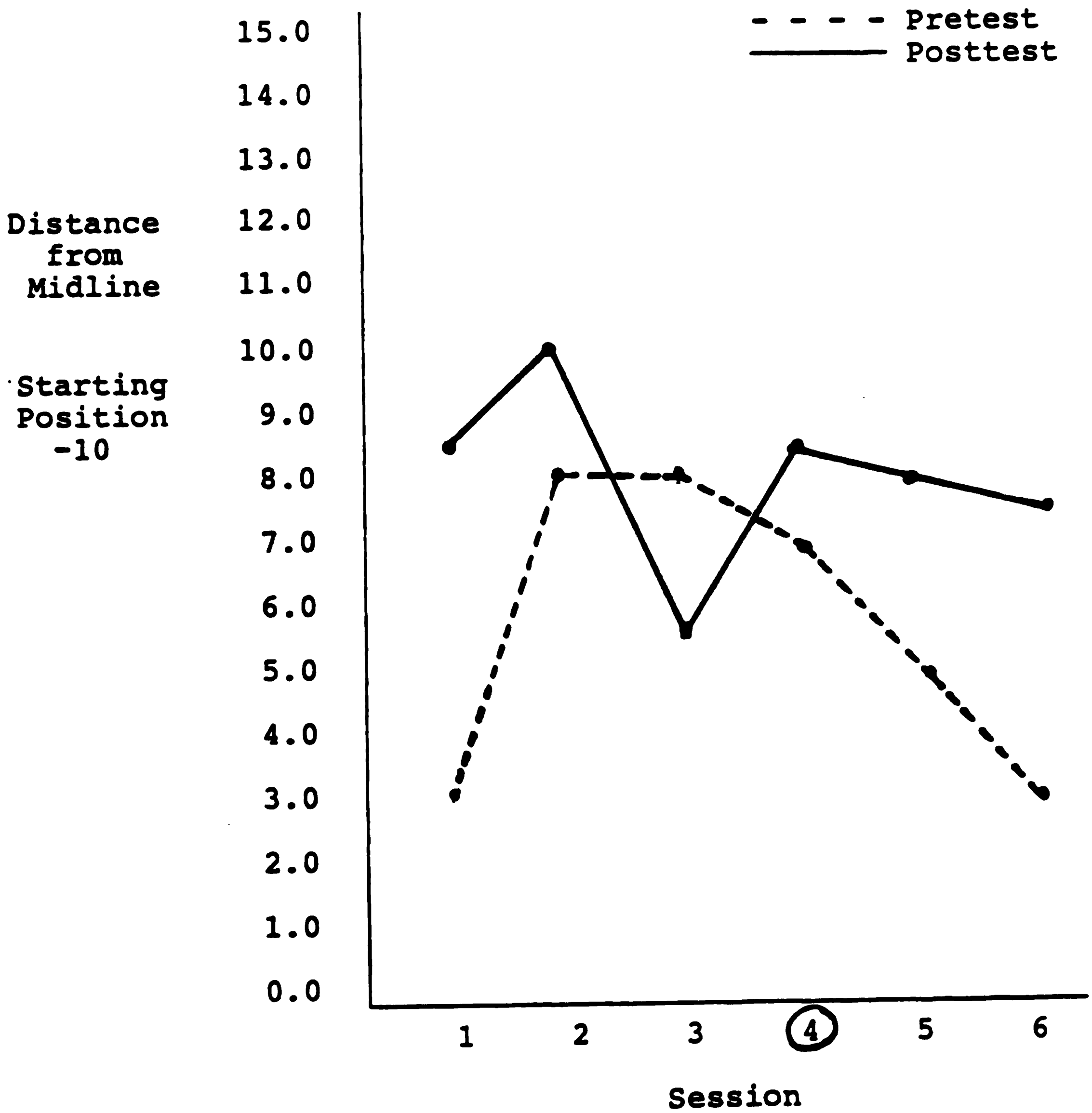


Figure 16. Pretest-posttest scores for arm motion task: Subject H

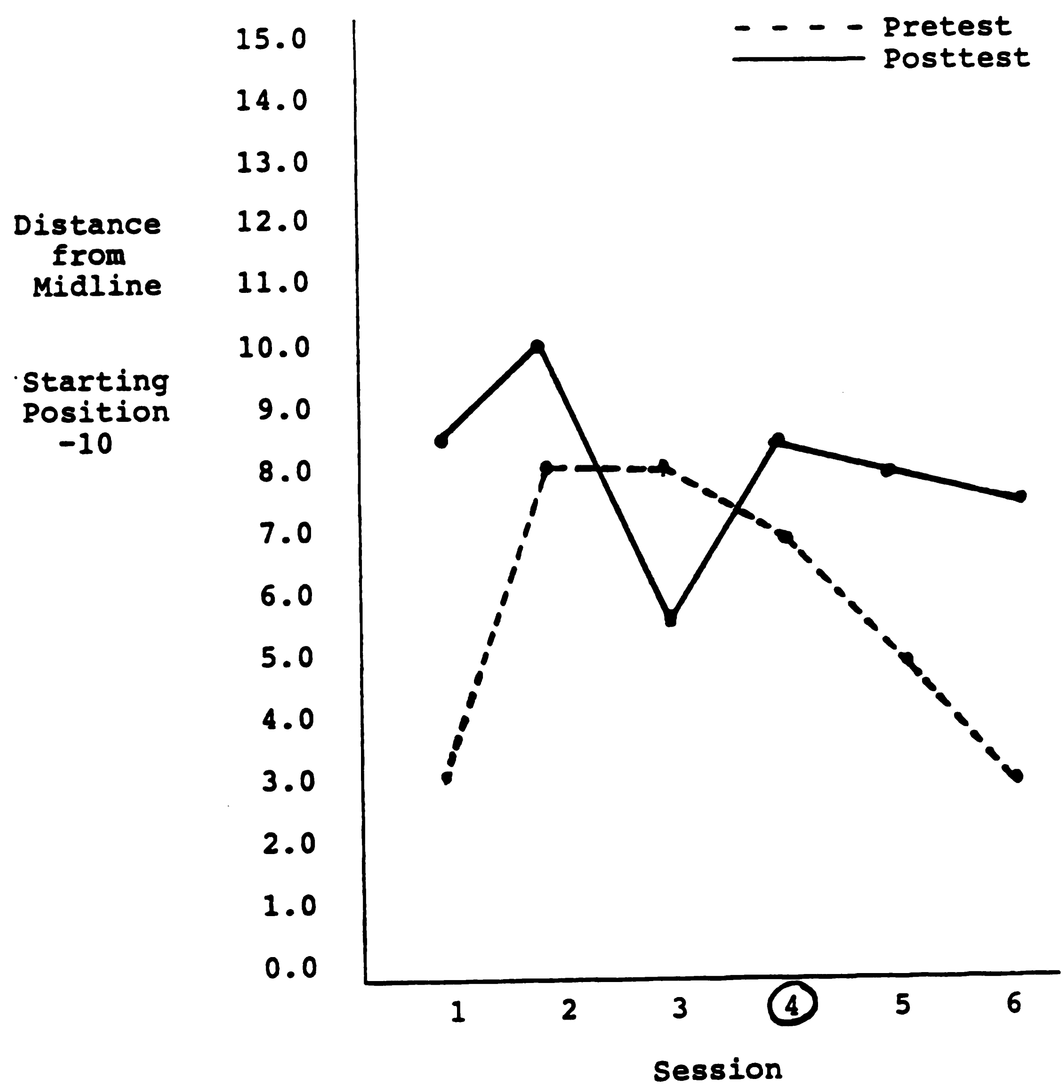


Figure 16. Pretest-posttest scores for arm motion task: Subject H

tending to turn the whole body to follow arm movement. The use of increased rotation in the posttest of Session 5 and back extension in the posttest of Session 6 led to substantial improvement in posttest scores from pretest levels. While movement generally increased the subject's muscle tone, a decrease of overflow tension into the left side was observed during Session 5 posttest task performance. Inexperienced in using the involved side for tasks, the subject displayed poor movement quality. Contacting the object with the side of the fingers and the wrist in flexed position, she tended to push the object and let go, rather than direct it along the board. Jerky movement, however, did not interfere with the attainment of higher posttest scores. A decrease in attention and effort was first observed in Session 3, and characterized much of the subject's behavior during the remainder of the experiment. This attitude, combined with poor movement skills, makes it difficult to assess the effect of the treatment from the task scores of Subject H.

# CHAPTER V

# CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

## Summary

The purpose of this study was to determine the effect of music listening on the reduction of excessive muscle tone in spastic cerebral palsied children. The subjects were eight spastic cerebral palsied children of elementary and middle school age who varied in extent and degree of disability. The study was conducted over a four-week period, with sessions held during school time in the subjects' schools. Each subject was treated individually by the experimenter in six 15-minute sessions. During the music listening period, subjects were exposed to either stimulative or sedative music, so that effects caused by differences in music type might be studied. Music treatment was replaced with a no-music condition in Session four, to determine if changes in subject behavior resulted from music treatment or other events occurring with treatment. The dependent variable, degree of muscle tone, was measured in each session before and after treatment. The two measures used were resting posture and task performance. Quantitative results were reported in tables and graphs, while qualitative results were presented in accompanying text. Quantitative results included tension ratings for resting posture and range of motion scores for the arm motion task. Qualitative results included descriptions of resting posture and of movement quality during task performance. In evaluating subject responses to treatment, the researcher was assisted by each subject's physical and occupational therapist, who viewed and assessed videotapes of subjects at rest and during task performance of Sessions five and six. The Mann-Whitney U test was used to analyze the effects of music type (sedative or stimulative) on resting posture and task performance.

## Conclusions

The following conclusions may be drawn about the relationship between music listening and the reduction of excessive muscle tone in cerebral palsied children. These conclusions apply only to the sample used in this study. A more detailed discussion of the conclusions may be found in the results, Chapter IV, under main findings.

1. Reduction of excessive muscle tone was observed in:

a. decreased postural tension of the subjects after exposure to music; all subjects showed a decrease in at least one session, but not in all

b. increased range of motion of subjects after exposure to music, when accompanied by improvement in movement quality; all but one subject showed an increase in at least three sessions, but not in all

2. Music listening seemed to produce a varying effect on the muscle tone states of the subjects. This varying effect may be illustrated by comparing the postural and task performance responses of subjects to the music condition with those to the no-music condition.

3. A comparison of the effects of the music condition and the no-music condition on the postural tension of the subjects showed that:

a. the music condition was more effective than the no-music condition as a means of reducing postural tension in two subjects

b. music and the no-music condition were equally effective in reducing postural tension in four subjects

c. music and the no-music condition were not effective as a means of reducing postural tension in two subjects

4. A comparison of the effects of the music condition and the no-music condition on the range of motion and movement quality of the subjects showed that:

a. the music condition was more effective than the no-music condition as a means of increasing range of motion with improved movement quality for four subjects

b. music and the no-music condition were equally effective in increasing range of motion with improved movement quality for two subjects

c. music and the no-music condition both led to increased range of motion without improvement in movement quality for one subject

d. the no-music condition was more effective than music as a means of increasing range of motion with improvement in movement quality for one subject

5. Music listening had a varying effect on the muscle tone states of the subjects over time. Measurement of postural tension indicated an overall decrease in muscle tone for three subjects, no change in muscle tone for three subjects, and an overall increase in muscle tone for two subjects. Measurement of range of motion indicated an overall increase in range for two subjects and an overall decrease in range for six subjects.

6. Stimulative and sedative types of music were equally effective as aids in the reduction of excessive muscle tone in these subjects. However, subjects receiving the stimulative-music treatment were more attentive overall to the music stimulus than were those receiving the sedative-music treatment.

## Discussion

In this study, the variety of subject responses to treatment reflects individual differences in neuromotor involvement and motor functioning ability. For example, while subjects E and F both lacked the capacity for independent trunk rotation, muscle tone in the trunk area was described as high for Subject E and low for Subject F. As a result, reduction of muscle tone as a response to treatment was characterized by decreased trunk rigidity, improved posture, and freer movement for Subject E. For Subject F, however, reduction of muscle tone was characterized by deterioration of posture and lack of trunk support during movement. In like manner, Subjects A and B, both severely involved quadriplegics, used abnormal reflex patterns to drive movement during task performance. Yet, reduced muscular tension improved the quality of movement for Subject A, while it decreased movement skill for Subject B. Because of such variations in subject response, the implications of the results of this study are first discussed in a subject-by-subject format.

Data for Subject A indicate both undesirable and desirable responses to treatment. The subject's lack of decrease in resting muscle tone was an undesirable result which must be viewed in light of a severe degree of involvement. As noted in the subject's initial sketch (Chapter III), relaxation was best accomplished when lying down or floating in water. Given the subject's high degree of spasticity and dependence on repositioning for increased range and relaxation, it is not surprising that the experimental treatment was ineffective in reducing excessive muscle tone. In this study, the need to maintain consistency of position for all subjects ruled out optimal positioning of Subject A for treatment.

The data for Subject A also indicate an increase in range of motion, a desired response to treatment. The subject used abnormal reflex patterns (ATNR, STNR) to move toward and across the midline. The increased effort required for this movement resulted in an increase in muscle tone during task performance. Therefore, the subject's increased range of motion (Sessions 2, 4, 5) cannot in itself be interpreted as an indication of reduction in muscle tone. However, qualities of movement denoting decreased tone were observed as part of reflex patterning; these were immediacy of initial response and increased smoothness of arm movement. Postural changes observed during posttest task performance also indicated decreased tone. These were flexion of head, mouth closure, and decreased movement of the inactive arm. Use of a less demanding task to measure muscle tone reduction (such as reaching forward to touch an object) would most likely have minimized the interference that reflex patterning had on positive effects of treatment.

Data for Subject B indicate both desirable and undesirable responses to treatment. A decrease in the subject's resting muscle tone in Sessions 2, 3, and 5 represented a desired result. The disparity between high and low posttest tension levels (Figure 2) might be explained by a hypersensitivity to external stimuli. It is possible that the music listening experience stimulated the subject in Sessions 1 and 6, and relaxed her in Sessions 2, 3, and 5. During physical therapy, however, Subject B responds best to passive movement, and is unable to relax with verbal suggestion alone. Since she attains relaxation best in a low-stimulus environment through hands-on guidance, one would not expect her to make a consistently positive response to the music stimulus.

A decrease in Subject B's range of motion represented an undesired result of treatment. Like Subject A, Subject B depended on abnormal reflex patterning to accomplish movement toward the midline. Movement was controlled by the STNR pattern, which required that the subject extend her head up and back in order to extend her arms to perform the task. Because her reflex patterning involved flexion of the head, preventing arm extension, Subject B, unlike Subject A, was unable to make effective use of the STNR pattern for task performance. Because effective use of the head and arms would have required an increase in muscle tone, Subject B's lack of movement skill implies a decrease in tone. In this case, reduction of muscle tone, although a desired result of treatment, becomes an undesired result because it hinders task performance. Because the subject's severe involvement made functional arm movement virtually impossible, simplification of the task would most probably not have resulted in improved quality of movement. For this subject, the most severely involved in the group, a more reliable measure of muscle tone reduction might involve use of the head, with decrease in involuntary movements indicating a decrease in tone.

Subject C responded to treatment with postural changes which clearly indicated a reduction in muscle tone. While decreased muscle tone represented a desired response to treatment, it tended to result in poor posture for this subject. Erect posture (alignment of head, shoulders, and trunk) gave way to slumping and leaning, which, in turn, marred overall body symmetry. However, relaxation of the subject's contracted left arm, observed in several responses, did constitute a desirable response to treatment. It is interesting to note that Subject C's drooping posture and sleepy affect were a response to stimulative music treatment. This suggests that the use of music as a tool for relaxation of muscular tension in these subjects need not be limited to the sedative type.

While music treatment regularly led to increased range of motion for Subject C, her poor posture, noted above, occasionally resulted in decreased quality of movement during task performance. Under these circumstances, the desired decrease in muscle tone was accompanied by lack of postural support for task performance. Although excessive muscle tone in spastic CP's interferes with motor control, the performance of motor tasks requires a certain degree of muscular tension. For Subject C, who lacked experience in the use of her contracted arm, increased effort was needed for smooth arm movement and control of direction. In Session 5, decreased movement quality was preceded by a marked deterioration in posture following music treatment. Since music treatment led to improved movement quality in Sessions 2 and 3 and decreased movement quality in Sessions 5 and 6, it is difficult to generalize about the effect of treatment on Subject C's task performance. On the basis of data from this study, one might conclude that music listening would benefit the subject in relaxing the muscles for guided movement, but would interfere with active movement requiring control based on increased physical effort.

Music treatment benefited Subject D in that it appeared to raise low abnormal resting tone (Sessions 1 and 3) and decrease higher abnormal tone (Session 6). In comparing pretest and posttest posture pictures for Session 6, one observer noted that music seemed to decrease the subject's higher abnormal tone, bringing her back to her normal underlying "floppy" tone. Because the subject presented low muscle tone during rest and high muscle tone (spasticity) during activity, normalization of muscle tone was a primary means of treatment in her therapeutic program. Normalization involved working with the subject in a low tone state to accentuate the use of normal, rather than spastic, muscles. Because music treatment appeared to improve the subject's posture (increased head control and erectness of trunk), it might prove a useful tool in Subject D's normalization program. Music thus benefited the subject even when it brought about an elevation of muscle tone. By increasing postural tension, music treatment worked against loose, floppy muscles, thereby aiding in the development of trunk control, an important treatment goal for Subject D. Since this result was a response to sedative music, one might expect an even stronger physical response, for Subject D, to stimulative music treatment.

For Subject D, increased range of motion with improved movement quality, a desired result of treatment, occurred in only two sessions. Although the task level was appropriate for the subject, her chair did not provide adequate trunk support for controlling arm movement across the midline. Proper positioning of the subject to eliminate forward or sidearm leaning would be necessary before making an accurate assessment of the effects of music listening on task performance. Because music treatment led to definite improvement in task performance in Sessions 3 and 5, it would be worth measuring its influence on this subject under more favorable conditions and over a longer period of time.

Data for Subject E indicate both desirable and undesirable responses to treatment. Decrease in postural tension after treatment was a desirable response observed throughout the study. Seating was an important variable influencing the degree of postural change in the subject. While relaxation of postural tone occurred in both wheel chair and electric car, changes in posture were most easily observed when the subject was positioned in the car. Unfortunately, the subject's regular wheel chair was unavailable for use at the time of the experiment. The supports on the wheel chair used in the study restricted relaxation of posture, especially with regard to shoulders and legs. Although shoulder supports were movable, attempts to reposition them were not successful. Changes in leg position indicated decreased tone might have occurred if the researcher had removed the support between the subject's legs and released the straps on his feet.

Variation in seating also influenced Subject E's range of motion and movement quality during task performance. Increased range of motion, a desirable effect of treatment, was accompanied by compensatory movement (flexion or extension) of the upper body. The effort required for these movements resulted in an elevation of muscle tone, which represented an undesirable outcome of treatment. In restricting upper body movement, the subject's wheel chair supports interfered with rotation, increasing the need for flexion, a compensatory movement. On the other hand, the freedom of movement afforded by the electric car only resulted in stronger compensatory movements, involving total body extension. Subject E's use of compensatory movement patterns arose from lack of independent rotation as well as poor positioning for task performance. In therapy, he required manual trunk rotation as well as proper postural support. Under these circumstances, music treatment could not be expected to improve the subject's rotation pattern. Since music had exerted a positive influence on postural tension, relaxing the subject's head, shoulders, and trunk, it might be effective in facilitating rotation during guided therapeutic exercise.

Data for Subject F indicate both desirable and undesirable effects of treatment. Because the subject presented high muscle tone in the lower body and low muscle tone in the upper body, reduction in postural tension was beneficial for the legs and hips, but detrimental to upper body posture. Although music treatment led to decreased trunk control, it might be useful in situations where reduced tone in the upper body was needed to gain range of motion. Because the locus of Subject F's muscular tension was in the lower body, changes in muscle tone might have been more significant if the camera had focused more on the hips and legs. Also, observation of the subject when lying down might have furnished more decisive evidence of tone change, as high tone was not easily observed in seated position. The subject's sleepy affect, taken as an indicator of reduced tone, may have been caused by morning fatigue and the confinement of the small experimental room as much as by the music treatment.

Increased range of motion for Subject F represented a positive response to treatment in Sessions 1 and 6, where substantial improvement in range was accompanied by improved movement quality (speed, smoothness, slight trunk rotation). Lacking independent rotation, the subject generally relied on compensatory movement (flexion of trunk and lifting of hips) to accomplish the arm motion task. As with Subject E, the effort required for these movements resulted in an elevation of muscle tone, an undesirable effect of treatment. A more appropriate task for measuring the effects of music listening on excessive muscle tone would have been arm elevation, which the subject could perform independently, or guided rotation.

Subject G responded to music treatment with decreased postural tension, which was attained through movement response to stimulative music. As noted in the results reported in Chapter IV, Subject G engaged in motoric behavior while in seated position. During the pretest, he manifested a general restlessness through random movements of hand and legs, accompanied by an increase in tone on the involved side of the body. Movement during the listening period increased in extent and intensity, appearing to be a direct response to the confinement of the small experimental room as much as by the music treatment.

Increased range of motion for Subject F represented a positive response to treatment in Sessions 1 and 6, where substantial improvement in range was accompanied by improved movement quality (speed, smoothness, slight trunk rotation). Lacking independent rotation, the subject generally relied on compensatory movement (flexion of trunk and lifting of hips) to accomplish the arm motion task. As with Subject E, the effort required for these movements resulted in an elevation of muscle tone, an undesirable effect of treatment. A more appropriate task for measuring the effects of music listening on excessive muscle tone would have been arm elevation, which the subject could perform independently, or guided rotation.

Subject G responded to music treatment with decreased postural tension, which was attained through movement response to stimulative music. As noted in the results reported in Chapter IV, Subject G engaged in motoric behavior while in seated position. During the pretest, he manifested a general restlessness through random movements of hand and legs, accompanied by an increase in tone on the involved side of the body. Movement during the listening period increased in extent and intensity, appearing to be a direct response to stimulative music. Movement during the posttest subsided, with decrease in muscle tone noted on the involved side of the body. Although movement, per se, involved an increase in muscle tone, the experience of movement to music seemed to loosen muscles on the subject's involved side. Subject G's physical therapist noted that jerky movement tended to increase muscle tone in spastics, while controlled movement tended to decrease it. In this case, movement to stimulative music might be regarded as controlled movement because the intensity and extent of the response corresponded with rhythmic and dynamic elements in the music. Under these circumstances, the subject attained relaxation not by listening alone, but as a result of moving to music. In support of this point, it should be noted that the subject's tension ratings were lower after moving to the music stimulus in Sessions 2, 5, and 6 than after sitting quietly during the no-music rest period in Session 4. Since controlled movement was noted as a means of decreasing muscle tone, music accompaniment might be used in treatment to guide Subject G from excessive body movement to more purposeful movement. A change in music type, from stimulative to sedative, might be used to further moderate physical response and thereby decrease muscular tension.

Although there was no noticeable increase in Subject G's range of motion in posttest task performance, there was increased fluidity of movement, made possible by decreased tone on the involved side of the body. Because movement to music helped release muscular tightness on the involved side, music treatment served to reduce excessive muscle tone during task performance.

Subject H's responses to treatment must be examined in light of a negative attitude, which increased as the study progressed. Lowering of the subject's postural tension, a desirable effect of treatment, was accompanied by a deterioration in posture. Poor posture, in turn, reflected a negative emotional state conveying lack of self-confidence and lack of trust in the environment. This affective state was conveyed in body language characterized by a twisted mouth, wrinkled, brow, downcast eyes, slumped shoulders, and fidgety hands. These behaviors continued throughout each session, remaining basically unchanged with music treatment. The subject's behavior was also marked by distractibility and hyperactivity, which increased in the course of the study. She found it difficult to sit still, continually looked around the room, played with her fingers, and even talked to herself during the final listening period. It is possible that Subject H's increased emotional and physical tension states were a response to sedative music treatment, and that the use of stimulative music, rather than sedative, might have captured her attention and elevated her mood.

The subject's negative attitude also influenced her task performance. She expended little effort in doing the task, shoving the object rather than maintaining contact with it, and averting her eyes from the focus of the task. She made little attempt at rotation until the last session, where she used back extension to accomplish greater range. The subject's increased range of motion (in four of five music sessions) and improved movement skill in the posttest of Session 6 indicated physical capability of performing the task. However, inexperience in using her involved side for tasks may explain her apparent lack of self-confidence during task performance. Examination of Subject H's responses to music treatment makes one acutely aware of the relationship between physical disability and self-concept. A music therapy program, using both movement and relaxation to help develop a more positive body image, would undoubtedly be beneficial for this subject.

The foregoing discussion calls attention to a number of variables that influenced subject responses in this study. These fall into two groups: subject variables and experimental variables. Subject variables included degree of disability, state of muscle tone, response to sedative music treatment, and that the use of stimulative music, rather than sedative, might have captured her attention and elevated her mood.

The subject's negative attitude also influenced her task performance. She expended little effort in doing the task, shoving the object rather than maintaining contact with it, and averting her eyes from the focus of the task. She made little attempt at rotation until the last session, where she used back extension to accomplish greater range. The subject's increased range of motion (in four of five music sessions) and improved movement skill in the posttest of Session 6 indicated physical capability of performing the task. However, inexperience in using her involved side for tasks may explain her apparent lack of self-confidence during task performance. Examination of Subject H's responses to music treatment makes one acutely aware of the relationship between physical disability and self-concept. A music therapy program, using both movement and relaxation to help develop a more positive body image, would undoubtedly be beneficial for this subject.

The foregoing discussion calls attention to a number of variables that influenced subject responses in this study. These fall into two groups: subject variables and experimental variables. Subject variables included degree of disability, state of muscle tone, music preference, and attentiveness. Experimental variables included positioning, music type, and task level. Because these variables were responsible for inconsistencies and differences in subject responses, they are considered important to the interpretation of the results of this study. The influence of each variable is discussed below.

1. Degree of disability: In this study, the degree of disability of each subject was described as severe, moderately severe, or moderate. The more severe the involvement, the less was the subject able to relax muscles in seated position. For the most severely involved, Subjects A and B, the best position for relaxation would be lying down, and the best aid to relaxation would be passive (hands-on) movement. Lesser involved subjects, however, were able to experience relaxation in seated position. The more severely involved subjects (A, B) lacked the voluntary arm movement required for effective performance of the arm motion task at the simplest level. Their use of abnormal reflex patterning interfered with the reduction of muscle tone or inhibited movement altogether. Lesser involved subjects (E, F) lacked the trunk rotation skill required for proper performance of the task at level 3. Their compensating movements (flexion, extension) served to elevate tone, working against any tone reduction that

might have resulted from treatment. Two subjects using the more involved arm for task performance (C, H) lacked the motor control necessary for consistent performance. In this case, the effect of treatment on task performance was difficult to evaluate.

2. State of muscle tone: Subjects differed as to their area of greatest spasticity or muscular tightness. Changes in muscle tone were difficult to observe in subjects whose spasticity was concentrated in the lower body (C, F, G) because the seated position of these subjects did not readily reveal such changes. Some subjects presented low muscle tone when at rest and higher muscle tone when involved in active movement. For these subjects (D, F, H), muscle tone reduction brought about deterioration of posture, an undesirable outcome which detracted from any positive results accomplished by the music treatment. For some subjects (B, C, D, H), reduction of muscle tone interfered with muscle tension needed for task performance, thus lowering range and movement quality. In contrast, subjects who presented a high resting tone (A, E, G) showed improved movement quality with decreased muscle tone.

3. Music preference: Subjects expressed like or dislike of the music stimulus through affect, comments, and behavior during listening. Enjoyment of the music was expressed through smiling, which occurred more in

earlier sessions of the experiment. Subjects described themselves feeling happy, sad, tired, or relaxed when listening. Two middle school subjects indicated preference for dance music and fast music. Subjects listening to sedative music appeared to tire of the music during the course of the study. In Session 5, Subject F maintained that she hated music, while in Session 6, Subject H counted aloud to 200 during the listening period. All subjects treated with sedative music expressed preference for the no-music condition used in Session 4 over the sedative music used in the other sessions. Subjects listening to stimulative music appeared to look forward to and enjoy the listening experience: Subjects A and C smiled, Subject G moved and vocalized to the rhythm of the music, and Subject E wore a look of concentrated attention. Only one of four subjects treated with stimulative music preferred the no-music condition to music. Given the variety of responses to the music stimulus, it is assumed that music preference was an important influence on individual subject behavior in this study.

4. Attentiveness: Subjects indicated their attentiveness by the extent to which they followed directions, behaved appropriately during music listening, and recalled steps in task performance. The most attentive subjects (A, C, E) were those most willing to

cooperate throughout the study, while the least attentive (F, H) were those who showed negative attitudes toward treatment. Attentiveness correlated with music type in that subjects listening to stimulative music were more attentive throughout the study than those listening to sedative music. Attentiveness was also influenced by duration of the study, with most subjects focusing on the music better in the earlier sessions, and some subjects (D, F, H) showing distractibility in later sessions. For some subjects, attentiveness was closely tied to psychosomatic makeup, so that hyperactivity (Subjects G and H) or low energy (Subject F) interfered with concentration.

5. Positioning: The seated position, in general, inhibited relaxation in the subjects. Wheel chair supports restricted change in both upper and lower body position, and trays used by the most involved subjects dictated arm position. In some cases, wheel chairs that did not provide adequate trunk and head support promoted poor posture, thereby causing muscle tone changes in the subjects. Positioning affected the task performance of two subjects in the form of inadequate wheel chair support (Subject D) and overly restrictive support (Subject E). Change of seating for Subject E, who used both wheel chair and electric "car," interfered with analysis of the subject's responses over

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the experimental period. The chair and table arrangement for the lesser involved hemiplegic subjects, G and H, was adequate for both relaxation and task performance. Seating for the other subjects was particularly problematic because no single seating arrangement was appropriate for both relaxation and task performance, and repositioning of subjects would have interfered with any effects of treatment on muscle tone.

6. Music type: Subjects treated with stimulative music responded more positively to the music stimulus than did those treated with sedative music. Because stimulative music seemed to increase enjoyment and attentiveness, it may have influenced the level of participation of these subjects, who appeared more cooperative, alert, and self-confident. Despite the different moods created by stimulative and sedative music, subjects experienced decreased tension under each music type. On the other hand, both music types contributed to an increase in tension, sedative for Subject D, and stimulative for Subject A. It was a coincidence that Subjects G (motoric) and F (phlegmatic) were treated with music types that accentuated their physical and emotional characteristics. Stimulative music treatment intensified G's impulse toward movement, while sedative music treatment further depressed F's lethargic mood and physical state. Sedative music had

the opposite effect on Subject H, whose increasing distractibility suggests a relationship between this music type and a rise in physical and emotional tension.

7. Task level: The division of the arm motion task into three levels of difficulty did not meet the needs of some of the subjects. The level one task was not suitable for the most involved subjects, A and B, because it elicited abnormal reflex patterns which elevated muscle tone during task performance. This rise in muscle tone represented an undesired outcome of music treatment, which was intended to decrease excessive tone in the subjects. The level three task posed the same problem in the case of Subjects E and F, whose lack of rotation skill necessitated the use of compensating movement patterns that raised muscle tone. In the case of these four subjects, the arm motion task was not an appropriate measure of the effect of music listening on excessive muscle tone, because task performance itself served to increase the muscle tone of the subjects. The level two task was more appropriate for the two subjects who performed it, as the skill needed to cross the midline did not demand excessive effort from them. Also, the level three task was suitable for the two hemiplegic subjects, whose involvement on one side of the body still permitted some type of rotation. The uniqueness of each subject with regard to impairment and motor ability

demanded even more task differentiation than was planned for this study.

The difficulties inherent in designing tasks appropriate for the CP subjects in this study suggest the need to examine the relationship between range of motion, movement quality, and muscle tone state of the subjects. In this study, increased range of motion was used as an indication of reduction of muscle tone. However, if increased range was accomplished with great effort, as used in reflex patterning or compensatory movement, then it was associated with an elevation of muscle tone. On the other hand, if increased range was accomplished with relative ease of movement and a more normal movement pattern, involving independent arm movement or some degree of rotation, then it was associated with a reduction of muscle tone. For example, Subjects A and E achieved high range of motion scores in the posttest of Session 5, Subject A using the ATNR pattern and Subject E using total body extension. Both subjects were observed to be in a high muscle tone state during task performance. On the other hand, both subjects used less effort to achieve relatively high scores in the posttest of Session 6. At this time, both manifested decreased muscle tone, Subject A through better postural control, and Subject E, through smoother movement.

In some cases, a decrease in range of motion also indicated a reduction in muscle tone for these subjects. Subjects who achieved low scores because of poor movement skill tended to present a low muscle tone state during task performance. For example, Subject B's "swiping away" arm movement, which led to a lower score in the posttest of Session 5, denoted less tension than her movement in the pretest, where she used more directional control to attain a higher score.

At this point in the discussion, a distinction must be made between the muscle tone states of subjects during task performance and those prior to task performance. Because the muscle tone of spastic CP's normally increases with movement, elevation of tone during movement did not mean that there was no prior reduction of tone. For example, Subject E experienced a decrease in postural tension before his high-toned posttest task performance in Session 5. His increase in muscle tone occurred with movement, and his increased range of motion most probably resulted from increased effort rather than from reduction in tone before task performance. While reduction of muscle tone with treatment did not preclude elevation of tone during task performance, in some cases it led to a decrease in muscular tension during performance. In Session 5, decrease in postural tension with treatment seemed to influence the task performances of Subjects B and C, who were described as lacking sufficient tone for moving the object. Although the beneficial effects of the music treatment on excessive muscle tone did not necessarily extend into the period of task performance, the use of music during task performance might have helped to decrease muscular tension at the time of movement. Used in this way, the music would represent an alternative stimulus to the movement cue, which normally causes an increase in muscular tension in spastic CP's.

Additional ways of using music in the treatment of spastic CP children are suggested by the findings of this study. These are listed as follows:

1. Music listening before therapeutic exercise or music accompaniment during therapeutic exercise might be used to relax the muscles for passive movement. For example, music used to reduce muscular tension in the subjects who required manual trunk rotation might facilitate movement, thus helping to gain range of motion. In selecting music for relaxation, variety should be considered, with stimulative as well as sedative types included if effective.

2. Music might be used to increase postural tension to overcome excessive looseness of muscles. Any music stimulus that encouraged a more erect posture

influence the task performances of Subjects B and C, who were described as lacking sufficient tone for moving the object. Although the beneficial effects of the music treatment on excessive muscle tone did not necessarily extend into the period of task performance, the use of music during task performance might have helped to decrease muscular tension at the time of movement. Used in this way, the music would represent an alternative stimulus to the movement cue, which normally causes an increase in muscular tension in spastic CP's.

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2. Music might be used to increase postural tension to overcome excessive looseness of muscles. Any music stimulus that encouraged a more erect posture

would aid in the development of head and trunk control, an important goal for many CP's.

3. Music might be used during movement to encourage fluidity and increase control. For example, the flow of a long melodic line might help to improve jerky movement quality, while the repetition of a rhythmic pattern might help to regulate excessive movement in the hyperactive CP.

4. Music might be used as a focus of concentration to increase attentiveness in the classroom as well as during therapy. Since the effect of the music treatment in this study was in part governed by the music preferences of the subjects, the selection of music used with CP's should be based on its appeal to the listener. In this study, both the novelty of the music experience and the music type appeared to determine the appeal of the music for the subjects.

5. Because physical disability impedes the growth of self-confidence and restricts outlets for self-expression, the use of music is suggested as a means of developing a more positive body image. As a stimulus to pleasurable movement activity, music might help release physical and emotional tension, and increase adaptability and confidence in the use of the body.

## Recommendations for Research

Because of the small number of subjects in this study, and their differences in degree and extent of disability, the format of a behavioral study was adopted for this investigation. The results of the research represent the responses of eight individual cerebral palsied subjects, each unique in diagnosis and behavior. Thus, while the study may contribute to what is known about treating muscular tension in these subjects, it does not provide conclusions that can be generalized to others in the CP population.

The following recommendations for research involve changes in the sample, music treatment, and procedure of the present study.

1. Use a case study format to study one subject, combining treatment and measurement over a longer period of time. The focus on one subject would overcome difficulties posed by individual differences among subjects, while measurement over a longer period would average out inconsistencies in subject responses. With only one subject to consider, the researcher could design a test procedure to better suit the needs of the subject. This would include a resting position that best facilitates relaxation, and a task that best fits the subject's motor functioning level.

2. Study CP subjects who are similar in neuromotor involvement--for example, severely impaired spastic quadriplegics or moderately involved spastic hemiplegics. Narrowing down the qualifications of the subjects would allow an experimental procedure more appropriate to the disabilities of the subjects.

3. To avoid the difficulties involved in matching CP subjects for two treatment groups, study the effects of stimulative and sedative music by varying the music treatment, using both types with each subject. Variation in music selections is recommended to preserve the positive effect of novelty.

4. Study the effects of preferred music on the responses of CP children. This would take into account the importance of affective response as an influence on attentiveness to the music stimulus.

5. When studying the effects of music on CP's, administer the music treatment to the subjects during the measuring period. That is, play the music listening selections while recording the subjects' resting postures and while the subjects are performing the task. Measuring the subjects while they are listening to music, rather than afterwards, would provide information about the immediate effect of the music stimulus on muscular tension. Eliminating the gap between treatment and measurement is especially important for CP's, who tend to

be highly sensitive to external stimuli. Measuring subjects while they are resting or moving to music would also be a better way to assess the effectiveness of the music as a facilitator of relaxation or of movement in CP's.

6. Study the effect of music on excessive muscle tone by using only one measure of muscle tone reduction. For example, using resting posture alone as a measurement of muscular tension would permit positioning of subjects for greater degree of relaxation. The resting position would not be restrictive, because subjects would not need added support for task performance. Subtle changes in posture could be recorded by measuring subjects before, during, and after music listening. With subjects in optimal position for relaxation, it would be easier to observe parts of the body that most reflect changes in muscle tone state.

Additional recommendations for research are listed as follows:

1. Study the relationship between degree of disability and responses to music treatment in spastic CP children.

2. Study the relationship between music listening and involuntary movement in severely involved spastic children.

be highly sensitive to external stimuli. Measuring subjects while they are resting or moving to music would also be a better way to assess the effectiveness of the music as a facilitator of relaxation or of movement in CP's.

6. Study the effect of music on excessive muscle tone by using only one measure of muscle tone reduction. For example, using resting posture alone as a measurement of muscular tension would permit positioning of subjects for greater degree of relaxation. The resting position would not be restrictive, because subjects would not need added support for task performance. Subtle changes in posture could be recorded by measuring subjects before, during, and after music listening. With subjects in optimal position for relaxation, it would be easier to observe parts of the body that most reflect changes in muscle tone state.

Additional recommendations for research are listed as follows:

1. Study the relationship between degree of disability and responses to music treatment in spastic CP children.

2. Study the relationship between music listening and involuntary movement in severely involved spastic children.

3. Study the effect of music on excessive, uncontrolled movement in hyperactive CP children, using both stimulative and sedative music types.

4. Study the effect of music on muscular tension in mentally impaired spastic CP children. Mentally impaired CP subjects functioning below the educable level were not included in this study in order that subject variability be kept to a minimum. However, since at least 50% of CP's are seriously mentally impaired, a study of muscle tone changes in mentally impaired spastic CP children would be useful, and would probably generate a larger sample than was available for this study.

3. Study the effect of music on excessive, uncontrolled movement in hyperactive CP children, using both stimulative and sedative music types.

4. Study the effect of music on muscular tension in mentally impaired spastic CP children. Mentally impaired CP subjects functioning below the educable level were not included in this study in order that subject variability be kept to a minimum. However, since at least 50% of CP's are seriously mentally impaired, a study of muscle tone changes in mentally impaired spastic CP children would be useful, and would probably generate a larger sample than was available for this study.

# APPENDICES

# APPENDIX A

# GLOSSARY OF TERMS

## GLOSSARY OF TERMS

Abduction: A movement away from the midline of the body.

Activities of Daily Living: Routine daily tasks, such as eating, dressing, grooming.

Adduction: A movement toward the midline of the body.

Asymmetrical Tonic Neck Reflex (ATNR): A reflex normally present during infancy, but abnormal if persisting beyond the sixth month. Turning of the head and neck in supine or seated position produces a position similar to the fencer's "on guard:" extension of the arm on the side of the body facing the head, and acute flexed position of the other arm. In supine, the lower limbs assume a position similar to the arms. Persistence of the reflex prevents independent movement of the head and limbs.

Contracture: Condition of permanent tightness in the muscles and joints.

Extension: Straightening of the arm, leg, head, or trunk.

External rotation: Rotation of the limbs away from the midline of the body.

Flexion: Bending of the joints of the arm, leg, head, or trunk.

Hemiplegia: Paralysis of one side of the body.

Hypertonic: Having greater than normal muscle tone; tight.

Hypotonic: Having less than normal muscle tone; floppy and loose.

Internal rotation: Rotation of the limbs toward the midline of the body.

Midline: Imaginary line dividing the body into left and right sides.

Muscle tone: State of tension in muscles at rest and in movement.

Perceptual-motor: A term describing the interaction of the visual, auditory, tactual, and kinesthetic channels of perception with motor activity.

POHI (Physical and other health impaired): A term used to describe educational programs for children with orthopedic impairments or serious health problems, such as a heart condition, asthma, anemia, or diabetes.

Quadriplegia: Paralysis of all four limbs.

Range of motion: The distance through which a joint can move.

Rotation: Turning or movement of the body around its axis.

Reflex: An involuntary movement response to sensory input.

Sensorimotor: Referring to motor activity caused by sensory stimuli.

Spastic: A condition of increased muscular tension, characterized by stiff muscles and lack of coordination of movement.

Symmetrical Tonic Neck Reflex (STNR): A reflex normally present during infancy, but abnormal if persisting beyond the sixth month. Extension of the head and neck produces extension of the arms and flexion of the legs. Flexion of the head and neck produces flexion of the arms and extension of the legs. Persistence of the reflex prevents independent movement of the head and limbs.

# APPENDIX B

# RAW DATA

TABLE B.1.--Table of Raw Scores: Resting Posture[a]

| Subject | | Session 1 | Session 2 | Session 3 | Session 4 | Session 5 | Session 6 |
|---|---|---|---|---|---|---|---|
| A | Pretest | 4-2 | 3-2 | 2-3 | 3-2 | 3-3 | 2-1 |
| | Posttest | 3-2 | 3-2 | 3-2 | 4-2 | 4-3 | 2-2 |
| B | Pretest | 3-3 | 3-2 | 3-3 | 3-3 | 3-3 | 3-3 |
| | Posttest | 4-4 | 2-1 | 2-2 | 2-2 | 2-2 | 4-4 |
| C | Pretest | 3-3 | 3-3 | 3-3 | 3-3 | 3-3 | 2-3 |
| | Posttest | 1-2 | 2-2 | 2-2 | 2-2 | 2-2 | 2-4 |
| D | Pretest | 2-2 | 2-2 | 2-2 | 2-3 | 3-3 | 3-3 |
| | Posttest | 3-4 | 2-2 | 3-3 | 2-3 | 3-3 | 2-2 |
| E | Pretest | 5-3 | 5-3 | 4-3 | 4-3 | 5-4 | 4-3 |
| | Posttest | 3-3 | 3-2 | 3-3 | 3-3 | 3-3 | 3-2 |
| F | Pretest | 2-3 | 2-3 | 2-3 | 2-4 | 3-4 | 3-3 |
| | Posttest | 2-2 | 2-2 | 2-2 | 2-3 | 3-3 | 2-2 |
| G | Pretest | 3-2 | 4-3 | 4-3 | 4-3 | 4-3 | 4-3 |
| | Posttest | 4-2 | 2-3 | 4-3 | 3-3 | 2-2 | 3-2 |
| H | Pretest | 2-3 | 3-3 | 3-5 | 3-5 | 3-3 | 3-3 |
| | Posttest | 2-2 | 2-2 | 3-4 | 3-4 | 4-2 | 3-2 |

[a]The two raw scores given for each pretest and posttest represent the separate ratings of two observers. The average of these two ratings was used to compute the resting posture gain-score for each session.

TABLE B.2.--Table of Raw Scores: Arm Motion Task

| Subject | | Session 1 | Session 2 | Session 3 | Session 4 | Session 5 | Session 6 |
|---|---|---|---|---|---|---|---|
| | | | | Level 1 | | | |
| A | Pretest | -5 | 1 | 3 | 1 | 2.5 | 1 |
| | Posttest | -3 | 3 | 2 | 3 | 3.5 | 1 |
| B | Pretest | -2.5 | 1 | 0 | 1 | 0 | 0 |
| | Posttest | -3.0 | 0 | 0 | 1 | -1 | -4 |
| | | | | Level 2 | | | |
| C | Pretest | 5 | 5 | 4 | 4 | 4 | 4 |
| | Posttest | 7 | 6 | 6 | 5 | 5 | 5 |
| D | Pretest | 4 | 4 | 5 | 5 | 4 | 5 |
| | Posttest | 4.5 | 4 | 6 | 3 | 6 | 5 |
| | | | | Level 3 | | | |
| E | Pretest | 4.5 | 4 | 4.5 | 8 | 11 | 8 |
| | Posttest | 6 | 5 | 6 | 8 | 14 | 9 |
| F | Pretest | 10 | 7 | 6.5 | 2 | 13 | 6 |
| | Posttest | 14 | 11 | 7 | 3 | 11 | 13 |
| G | Pretest | 14 | 10 | 13 | 14 | 14 | 14 |
| | Posttest | 14 | 14 | 14 | 14 | 14 | 15 |
| H | Pretest | 3 | 8 | 8 | 7 | 5 | 3 |
| | Posttest | 8.5 | 10 | 5.5 | 8.5 | 8 | 7.5 |

TABLE B.2.--Table of Raw Scores: Arm Motion Task

| Subject | | Session 1 | Session 2 | Session 3 | Session 4 | Session 5 | Session 6 |
|---|---|---|---|---|---|---|---|
| | | | | Level 1 | | | |
| A | Pretest | -5 | 1 | 3 | 1 | 2.5 | 1 |
| | Posttest | -3 | 3 | 2 | 3 | 3.5 | 1 |
| B | Pretest | -2.5 | 1 | 0 | 1 | 0 | 0 |
| | Posttest | -3.0 | 0 | 0 | 1 | -1 | -4 |
| | | | | Level 2 | | | |
| C | Pretest | 5 | 5 | 4 | 4 | 4 | 4 |
| | Posttest | 7 | 6 | 6 | 5 | 5 | 5 |
| D | Pretest | 4 | 4 | 5 | 5 | 4 | 5 |
| | Posttest | 4.5 | 4 | 6 | 3 | 6 | 5 |
| | | | | Level 3 | | | |
| E | Pretest | 4.5 | 4 | 4.5 | 8 | 11 | 8 |
| | Posttest | 6 | 5 | 6 | 8 | 14 | 9 |
| F | Pretest | 10 | 7 | 6.5 | 2 | 13 | 6 |
| | Posttest | 14 | 11 | 7 | 3 | 11 | 13 |
| G | Pretest | 14 | 10 | 13 | 14 | 14 | 14 |
| | Posttest | 14 | 14 | 14 | 14 | 14 | 15 |
| H | Pretest | 3 | 8 | 8 | 7 | 5 | 3 |
| | Posttest | 8.5 | 10 | 5.5 | 8.5 | 8 | 7.5 |

TABLE B.2.--Table of Raw Scores: Arm Motion Task

| Subject | | Session 1 | Session 2 | Session 3 | Session 4 | Session 5 | Session 6 |
|---|---|---|---|---|---|---|---|
| | | | | Level 1 | | | |
| A | Pretest | -5 | 1 | 3 | 1 | 2.5 | 1 |
| | Posttest | -3 | 3 | 2 | 3 | 3.5 | 1 |
| B | Pretest | -2.5 | 1 | 0 | 1 | 0 | 0 |
| | Posttest | -3.0 | 0 | 0 | 1 | -1 | -4 |
| | | | | Level 2 | | | |
| C | Pretest | 5 | 5 | 4 | 4 | 4 | 4 |
| | Posttest | 7 | 6 | 6 | 5 | 5 | 5 |
| D | Pretest | 4 | 4 | 5 | 5 | 4 | 5 |
| | Posttest | 4.5 | 4 | 6 | 3 | 6 | 5 |
| | | | | Level 3 | | | |
| E | Pretest | 4.5 | 4 | 4.5 | 8 | 11 | 8 |
| | Posttest | 6 | 5 | 6 | 8 | 14 | 9 |
| F | Pretest | 10 | 7 | 6.5 | 2 | 13 | 6 |
| | Posttest | 14 | 11 | 7 | 3 | 11 | 13 |
| G | Pretest | 14 | 10 | 13 | 14 | 14 | 14 |
| | Posttest | 14 | 14 | 14 | 14 | 14 | 15 |
| H | Pretest | 3 | 8 | 8 | 7 | 5 | 3 |
| | Posttest | 8.5 | 10 | 5.5 | 8.5 | 8 | 7.5 |

# APPENDIX C

# RATING FORMS

RATING FORM: RESTING POSTURE SUBJECT ______ SESSION ______ THERAPIST ______

A. Pretest: Description of Muscle tone state

| Body Part | High tone | Moderate tone | Low tone |
|---|---|---|---|
| Head | | | |
| Face | | | |
| Shoulders/trunk | | | |
| Arms | | | |
| Hands/wrists/fingers | | | |
| Legs | | | |

Overall rating 1 2 3 4 5 (1 = lowest tone, 5 = highest tone)

Instructions:
1. Verbally describe position of each body part
2. Use appropriate column to indicate muscle tone states reflected by the position of each body part
3. Rate the muscle tone state on the basis of the verbal descriptions, using the rating scale provided

B. Posttest: Description of muscle tone state

| Body Part | High tone | Moderate tone | Low tone |
|---|---|---|---|
| Head | | | |
| Face | | | |
| Shoulders/trunk | | | |
| Arms | | | |
| Hands/Wrist/Fingers | | | |
| Legs | | | |

Overall rating 1 2 3 4 5 (1 = lowest tone, 5 = highest tone)

SESSION RATING SHEET: ARM MOTION TASK SUBJECT A

TASK LEVEL 1

ARM R

STARTING POSITION -6

PRETEST:

DISTANCE -5

COMMENTS Hand clenched during movement; needs time to respond

POSTTEST:

DISTANCE -3

COMMENTS Hand opened during movement; needed extra time to respond; coughing during listening period appeared to raise tone state.

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