This is to certify that the

thesis entitled

THE ABILITY OF DOWN'S SYNDROME SUBJECTS
TO SYNCHRONIZE RHYTHMIC MOTOR RESPONSE
TO THE BEAT OF A MUSICAL STIMULUS

presented by

Roger Aue Smeltekop, RMT

has been accepted towards fulfillment
of the requirements for

MASTER degree in MUSIC

Dale L. Bartlett
Major professor
Dale L. Bartlett

Date 3 August 1983

THE ABILITY OF DOWN'S SYNDROME SUBJECTS TO SYNCHRONIZE RHYTHMIC MOTOR RESPONSE TO THE BEAT OF A MUSICAL STIMULUS

By

Roger Aue Smeltekop, RMT

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF MUSIC, MUSIC THERAPY

Department of Music

1983

ABSTRACT

THE ABILITY OF DOWN'S SYNDROME SUBJECTS TO SYNCHRONIZE RHYTHMIC MOTOR RESPONSE TO THE BEAT OF A MUSICAL STIMULUS

By

Roger Aue Smeltekop

The purpose of this study was to examine the Down's Syndrome person's ability to synchronize motor responses to an external stimulus and to identify the relationship between synchronization accuracy and stimulus tempo, as well as age and intelligence.

Each of twenty-one DS subjects were randomly assigned to one of three experimental tempo conditions: slow, fast, or choice. They were tested in a performance task of playing a drum to a music stimulus. The stimulus and the motor response were recorded on a two-channel chart recorder. Deviations of the response beat length from the stimulus beat length were calculated and the mean differences were compared across experimental conditions and in relation to IQ and age.

Small differences in beat length deviation were found across the three group means. The tempo of choice had the least error, followed by the fast and then the slow. Only the difference between the tempo of choice and the slow tempo was found to be statistically significant. DS subjects showed a slight, but consistent, tendency to respond faster than the beat. No significant relationship was shown between synchronization accuracy and intelligence and age.

To my wife, Diane Cratsley,

whose personal support and generous assistance

were invaluable in the implementation and completion

of this study

ACKNOWLEDGEMENTS

Grateful appreciation is extended to Professor Robert F. Unkefer and Dr. Dale Bartlett for their support, guidance, and expertise contributed toward the accomplishment of this research study.

Thanks and acknowledgement are offered for individual help and contributions by Dr. Ron Newman, Diane Cratsley, Michael Thaut, Dr. David Fuller, and June McGregor-Lee.

A very special thanks is given to the Down's Syndrome children and adults and their parents for their very essential cooperation and participation in this study.

TABLE OF CONTENTS

LIST OF TABLES

ABBREVIATIONS

CA: chronological age

DS: Down's Syndrome

EMI: educable mentally impaired

EMR: educable mentally retarded

IQ: intelligence quotient

MA: mental age

RBL: response beat length (subject)

SBL: stimulus beat length (music)

TMI: trainable mentally impaired

TMR: trainable mentally retarded

CHAPTER I

THE PROBLEM

Introduction

The person with Down's Syndrome (DS) has long been a prominent member of the mentally impaired population. Considerable time and effort have been devoted by health professionals, families, and community members to the growth, development, and habilitation of these handicapped individuals. This seems largely due to the demonstrated adaptive ability and temperament characteristics that enhance the potential for DS people to make satisfactory adjustments to community life. Such adjustment is, in part, dependent upon the degree of development in communication, cognition, and social, emotional, and perceptual-motor functional skill areas, as well as upon the types of support systems present in the individual's environment. These factors combine to determine the level of independence a person can achieve in self-care, education, work, and leisure time activities.

Purpose of the Study

The purpose of this study was to examine the DS person's ability to synchronize motor responses to an external stimulus. In particular, it was intended to identify the relationship between synchronization accuracy and stimulus tempo, as well as synchronization accuracy and intelligence level. Since this specific skill has direct application in the area of music performance through the action of executing motor responses to the beat of music, this skill was tested in a musical context. A performance task was used rather than a discrimination task, despite the greater difficulty in logistics and instrumentation for testing, because rhythmic synchronization is most practical and relevant to everyday functioning in the performance mode.

Most studies have not made a precise measurement of the accuracy of rhythmic synchronization and have not described whether inaccuracies in this skill demonstrate any common characteristics, such as a tendency to lag or fall behind the beat. It has been observed in music therapy clinical settings that, while many DS clients enjoy rhythmic movement activities such as dancing and playing instruments, and perform them with apparent coordination and grace, their responses do not appear to be actually synchronized with the pulse of the musical accompaniment.

In certain types of musical pursuits, e.g. informal popular dancing, synchronization with the beat is not a requisite for enjoying the activity. In many others, such as ensemble playing or structured folk dance, the relative aesthetic and interpersonal success is highly dependent upon the participant's ability to coordinate the timing of his/her responses to the group's concerted efforts. Just as the ability to synchronize one's movements to an external stimulus can be important to music and other leisure time activities, this ability also has implications regarding a person's potential to successfully perform many types of work related functions (Clark and Hermelin, 1955; Fitzpatrick, 1959; Rowlson, 1983). The operation of many production-line machines or the performance of an individual repetitive task as part of an assembly line sequence often requires a timely response to a cue from another person or external source.

Need for the Study

This research is intended to add to the limited amount of literature in the area of rhythmic synchronization in DS. The results may also shed light on the precision of DS responses to music.

The effects of different tempi on the DS person's success at coordinating motor responses may be of use to health and education professionals. The way in which tempo influences synchronization may offer a principle through which work and leisure time activities can be accomplished more effectively and efficiently.

Specific implications for music therapy are that this study may provide a direction for future research and may identify a role that music therapy can serve in coordination with educational and vocational goals for DS people.

Research Questions

1. To what degree of accuracy can a DS person synchronize motor response to a regularly occurring external auditory stimulus (the beat of music)?
2. Do DS persons demonstrate similar characteristics in motor synchronization?
3. Is motor synchronization ability in DS persons affected by the speed of the stimulus events (the tempo of the music)?
4. Is there a significant relationship between motor synchronization ability and measured intelligence (IQ) and age in DS persons?

Assumptions

Down's Syndrome persons, as well as others who are mentally impaired (mentally retarded), have been shown to be somewhat difficult to test in situations that are unfamiliar to them and in which they are ill at ease (Cantor and Girardeau, 1959; Kaplan, 1977).

The procedure designed for the testing session, including a musical warm-up activity, a series of training items, the rhythmic synchronization test, and a closing musical activity, is believed to facilitate a higher level of responsiveness. Therefore, the performance scores for the DS subjects are expected to more closely reflect their actual abilities, with minimal interference from the novelty of the testing situation.

The DS person will respond at a closer to optimum skill level when performing to a musical stimulus. The recorded music to be used in this study was composed using harmonies common to popular musical styles, in the belief that music of this type would be familiar and motivating to the subjects. The music was performed on the piano in an effort to give it a percussive and clear quality.

Though the DS person is believed to be responsive to imitation (Fitzpatrick, 1959), the rhythmic synchronization tasks will be practiced with the experimenter, but the experimenter's modeling will be faded out to avoid the possibility of misleading the subject by any errors in the experimenter's performance during the measurement. This will also provide some assurance that the response is solely to an auditory stimulus, and not confounded by a possible discrepancy and/or conflict between the subject's auditory and visual perception skills.

There is some evidence that the level of coordination shown in performance of motor tasks using the arms and hands is not superior to coordination shown in tasks using the feet and legs. If this is the case, the rhythmic synchronization skill levels described by this study should generalize from drum beating activities to activities using the lower extremities using a similar single movement, such as tapping one foot or depressing a pedal. An early study reported a correlation of .80 between clapping and walking skills in normal subjects (Jersild and Bienstock, 1935).[1]

A later study indicated that rhythmic performance (defined as fine motor movement using hands) and rhythmic movement (defined as gross motor movement as in stepping and total body movement) correlated at .59. However, the measurement of the highly variable gross motor movement was made by "subjective assessments of a panel of judges who agreed upon the nature of the tests to be used and the points on which the subjects were to be assessed,"[2] a technique of questionable accuracy (Thackray, 1969).

Limitations

This study looked only at the DS person's skills in rhythmic synchronization as compared to a standard of absolute synchronization, measured accurately to within .01 second; it did not purport to describe the abilities in this skill area of the normal population. No attempt was made to identify the specific causes or origins of any of the rhythmic characteristics observed, but simply intended to describe them in the DS population in relation to intelligence and tempo chosen. This study did not attempt to compare the subject's performance with relation to sex.

While skills in rhythmic synchronization are most likely influenced by skills in general motor performance (Wight, 1937; Groves, 1969), the latter was not measured. However, any subjects who had specifically diagnosed motor or physical disabilities that might unusually influence the performance of the motor task, such as cerebral palsy or significant sensory impairment, were eliminated from the study.

The sample population was drawn from the Greater Lansing area (Michigan), and included only those who volunteered to participate in the study. In addition, the parents or guardians of subjects taking part had to be willing to transport the subject to the testing site on the Michigan State University campus. The degree to which the sample used represented the total DS population was also influenced by the limited number of available DS subjects. The above factors limited the generalizability of the experimental results and conclusions of the study.

Whether the level of skill in rhythmic synchronization possessed by a DS person could be improved through training or through altering the conditions, other than tempo, under which such tasks are performed was not within the scope of this investigation. However, the factors cited above could be very important when interpreting and/or applying the conclusions from this study. This is especially pertinent when making decisions regarding types of experiences to be provided in programs for DS persons.

It is not suggested that any lack of performance skill in this area is equated to lack of performance potential. Thus, it should not be the basis for restricting the DS person from programs or interventions designed to improve rhythmic synchronization. In like manner, the assumption cannot be made from results obtained in this study that instituting programs for motor performance will bring about an improvement in rhythmic synchronization.

Overview

In Chapter II the background of this study is presented in a literature review. A survey of rhythmic synchronization, particularly as it occurs in music, is made in the first section. The second section describes current findings on the characteristics of Down's Syndrome. In the last section selected studies of rhythm and motor skills in DS are reviewed.

Chapter III includes the methodology used in studying rhythmic synchronization in DS persons. The sample, design, measurement procedures, variables involved, and analysis of data are described. In Chapter IV the data collected are presented in relation to the relevant research questions investigated, and the results are interpreted. Chapter V is a summary of the study with the discussion of conclusions and suggestions for future research. The appendix includes a glossary of terms, a table of the raw data collected, the instructions to subjects in the testing session, and the musical examples used in the testing.

CHAPTER II

REVIEW OF RELATED LITERATURE

Overview

The review of related literature is divided into three major sections and a summary:

1. Rhythmic Synchronization and Music
2. Down's Syndrome
3. Studies of Rhythm and Motor Skills in DS
4. Summary

Each area is further broken down into sub-sections relevant to this study.

Rhythmic Synchronization and Music

The element of rhythm is a major factor in the successful performance of music. Teachers, researchers, and therapists in music have observed and investigated the acquisition of rhythmic skills with special interest in the processes by which they are acquired, the ages at which rhythmic achievements occur, and the influence that various factors, such as training, has on the development of these skills.

This study is concerned with just one basic facet of rhythm, that of the syrchronization of motor responses to an externally imposed musical beat in DS individuals.

Development of Rhythmic Skills

It is from the studies of normal rhythmic skill development that the foundation and perspective are gathered to guide the investigation of rhythmic skills in the handicapped.

Past researchers have concluded that rhythmic skills are usually acquired by age eight (Petzold, 1969) to age ten (Hufstader, 1977). Synchronization is reported to stabilize at five and one-half years (Williams, 1932) to seven years of age (Petzold, 1969; Cox, 1977). The predominant conclusion by researchers has been that as age increases, failure at rhythmic skills decreases (Vance and Grandprey, 1931; Sievers, 1932; Jersild and Bienstock, 1935; Gilbert, 1979).

Many studies of perceptual-motor skills involving subjects of normal and mentally retarded intelligence have matched experimental and control samples by mental age equivalents (Cantor and Girardeau, 1959; O'Connor and Hermelin, 1961; Peters, 1978; Dummer, 1978). However, one study matched samples of DS, autistic, and normals by performance scores in tapping speed and rotary pursuit tracking (Frith and Frith, 1974). The frequent use of mental age equivalents to compare normal subjects to mentally retarded subjects, who are consequently at a considerably higher chronological age, suggests that to look at normal rhythmic development might be of value in predicting the performance of mentally retarded subjects at various mental age levels.

Given that the mental ages of the majority of DS individuals fall below four years with the upper limit at seven years (Gibson, 1978), the measured performance levels to be shown by this study may be attributable to the low level of mental development rather than to any unique characteristic of the DS person's genetic make-up. In other words, the DS subject may not have reached the mental age at which motor synchronization skills are acquired.

A number of researchers have shed light on the development of rhythmic skills through the study of Jean Piaget's stages of cognitive development (Pflederer, 1967). Conservation skills are those through which a child recognizes that some properties of an object or event remain constant at the same time that other properties are altered. For example, conservation of volume is exhibited by the acknowledgement that a liquid in a short, wide container remains equal in volume when transferred to a tall, thin container.

Zimmerman and Sechrest (1970) concluded that age is a significant factor in the acquisition of conservation skills. In their study, a common melody was played and then repeated, either exactly the same or with the deformation (change) of one musical element. The subjects were asked to identify "same, different, or same and different", and then describe the ways in which they perceived any difference. Subjects were given conservation scores based on their recognition of changes in rhythm and tempo, as well as instrument, harmony, melodic contour, melodic interval, and mode.

Included in Jones' (1976) study of the conception of meter in music, was a conservation of velocity task in which the subject watched the passage of two equal time intervals of fifteen seconds on a stopwatch, but with a metronome ticking at a different rate each time. The subject was then asked if the stopwatch hand went the same speed both times. His results indicated that this skill was achieved by the age of seven years.

In a follow-up of Jones' work, Perney (1976) conducted a similar investigation of conservation of metric time in second and third graders.

> A person who is a conserver with respect to metric time can accurately relate the duration of events and the speed at which the events take place. Before conservation of metric time is acquired, a child's 'internal clock' is not invariant; that is, certain changes in the child's environment can cause the child's 'clock' to vary in speed.[3]

While the performance of the second and third graders did not significantly differ, he found support for his hypothesis that performance on the musical tasks were significantly related to verbal ability, more than age.

From the writings of Piaget and others, Bagenstos and LeBlanc (1975) concluded that learning in relation to time was premature before age seven, and therefore did not study it in their "Aesthetics in the Physical World" program (CEMREL, Inc.) for kindergarten and first grade.

Cantor and Girardeau (1959) reported that neither a DS group with a mean mental age of 4-4 (years-months) nor a normal group with a mean mental age of 5-6 successfully tapped synchronously to a metronome.

Kaplan (1977) compared subjects who were EMR (higher level than most DS) of six, seven, and eight years of mental age with normal six, seven, and eight year-old children. She found no significant differences between them in response to musical beat, with the exception of echo tapping skills, in which the normals were superior.

Measurement of Rhythmic Synchronization

Evidence for rhythmic skill has been gathered for research by means of evaluating both performance skills and discrimination skills. A number of researchers have indicated the benefit and need for performance studies.

Pflederer (1964) in her study of five to eight year-olds' abilities to use Piaget's principle of conservation in musical tasks, noted that the children achieved correct discriminations more readily when they overtly interacted with the task, in such ways as clapping or counting. "The child seemed to reason with a form of sensori-motor intelligence wherein his own actions served as a guide for thought by providing a model to guide his judgement in solving the task."[4]

Among the recommendations made by Kuhn (1974) for future research was that investigations of the recognition of tempo modulation be done as studies of music performance, rather than discrimination.

Zimmerman and Schrest (1970) studied the effects of "brief focused instruction" on the acquisition of musical concepts, one of which was tempo, in normal children ages five to thirteen. One of their recommendations was that "some type of musical task be devised in which the critical response is not dependent upon verbal capabilities."[5]

Andrews and Deihl (1970) stated that overt and manipulative measures would have particular value with handicapped children. Regarding DS individuals, Gibson (1978) added: "Maintenance of a single interest is more often evident when motor discharge is continuously engaged, as in dancing or mimicry".[6]

Research evidence indicates that the relationship between rhythmic perception skills and rhythmic performance skills in normal subjects is

positive but not close. Thackray (1969) found a correlation of .63 between these two skill areas.[7] Other researchers have also suggested a small relationship between perception and performance skills in normal musically trained subjects (Marciniak, 1974) and very young musically non-trained normal subjects (Andrews and Deihl, 1970). Cantor and Girardeau (1959) found that motor response to a rhythmic stimulus aided neither normals nor DS subjects to discriminate and identify fast and slow tempi.

Various methods of measuring rhythmic performance have been employed to gather data for research. Some researchers have used observational ratings by expert judges, either during testing (Thackray, 1969; Ross, Ross, Kuchenbecker, 1973) or by videotaped replay (Gilbert, 1979). Others have used performance sections of standardized tests.

Past studies, however, have indicated that observational measurements are inaccurate in comparison to objective measures (Heinlein, 1929; Jersild and Bienstock, 1935). Most of the objective measurements reviewed have recorded responses within tolerances of as low as .05 second up to .10 second (Sievers, 1932; Jersild and Bienstock, 1935; Petzold, 1966; Kaplan, 1977). Smoll (1975) measured temporal accuracy to within .01 second.

McDowell (1977) designed a Rhythmic Ability Test of several sections, one of which measured the subject's ability to reproduce a tempo given by a metronome. Each subject was presented with eight beats of an audible tick and a visible flash of light, followed by eight beats of just the flashing light. During the latter eight beats, the subject was to reproduce the tempo by playing on a woodblock. The response was tape recorded, and one point was given if there were eight taps during the eight silent beats. He tested each subject at the following tempi: 60, 66, 72, 80, 88, 96, 104, 112, 120, and 132 beats/minute. He found that the eight-year-olds he tested performed better than four-year-olds, that subjects tended to reproduce the faster tempi better than the slower ones, and that one month of specific rhythm training did not significantly improve the scores of the four-year-olds in his sample.

A recent study was conducted by Phyllis Kaplan (1977) using electronic technology to measure rhythmic responses of normal and EMR children. She devised a Test of Rhythmic Responsiveness which contained five subtests of rhythmic skill:

I. Beat

II. Tempo Change: Gradual

Tempo Change: Sudden

III. Accent (as a factor in meter discrimination)

IV. Durational Patterns: Melodic Rhythm

Durational Patterns: Echo Tapping

V. Ostinato[8]

Of particular interest was her use of the TAP Master (developed by David L. Shrader and produced by Temporal Acuity Products, Inc.) on subtest I. Beat. The device played music on a cassette tape to which electronic impulses had been added to coincide with the music's beat. When the subject pressed a button within $\pm$.10 second of the beat, a digital counter recorded the correct response and an auditory feedback "beep" was given to the subject. Subjects were given practice items and were tested on these items at each of the following tempi: 66, 108, 160 beats/minute. Subjects were observed during the measurement, and no credit was given for double-time tapping. Scores on this subtest were taken from the tally on the digital counter.

Kaplan tested twelve subjects in each of six groups: normals grouped by ages six, seven, and eight years, and EMR's grouped by mental age equivalents of six, seven, and eight years. No significant differences were found between the normals and EMR subjects on this test.

Kaplan reviewed the technology used by several researchers prior to her study:

1. Baldwin and Stecher (1924) recorded responses through wooden clappers wired to an electronic kymograph.
2. Heinlein (1929) electrically wired the floor to record the subjects' actual steps through kymograph pens (also for each step observers simultaneously tapped telegraph keys attached to the kymograph, to test for accuracy of observational judgements.)
3. William's (1932) subjects tapped a brass plate with a hammer to a ticking clock, recorded by the deflection of a spiral pen attached to a turntable.
4. Jersild and Bienstock (1935) determined synchronization by filming a blinking light stimulus, a one revolution/second clock, and the subject's response simultaneously. They then examined each film frame to determine accuracy within a $\pm.08$ tolerance; they counted only responses preceded by a correct response.
5. Petzold (1966) used a two channel polygraph to give a simultaneous record on paper of the stimulus (metronome beats) and the subject's response (tapping on a metal plate); he scored thirty responses beginning with the first one correct within a tolerance of $\pm.06$ second.[9]

In an investigation of the ability of trained musicians to accurately perform rhythmic notation, Drake (1968) devised an electronic apparatus to produce a regular, audible, metronomic click and an audible pure tone upon the independent tapping of a key, both of which were electronically recorded on magnetic tape. The subject performed notated rhythms by tapping on the key to the beat of the metronome click, which was silenced after the performance of each item had begun. The data collected on the magnetic tape were transferred to visual form through the use of a Dynograph chart recorder. Of interest to this study was his calculation of error in beat accuracy. Beat reproduction error was measured by the difference between a required beat length and the mean of the observed (subject's) beat lengths for an item. Beat steadiness error was measured by the difference between an observed beat length and the mean of the observed beat lengths of an item.

The Influence of Tempo

Tempi used by other researchers in studying rhythmic skills are represented by the following ranges:

	slow - fast (beats/minute)
Williams, 1932	60 - 120
Cantor and Girardeau, 1959	88 - 120
Petzold, 1966	60 - 182
Kuhn, 1974	60 - 150
McDowell, 1974	60 - 132
Taebel, 1974	84 - 112
Kaplan, 1977	60 - 160
Dorhout, 1979	60 - 120

Petzold reported that at 60 beats/minute, subjects often gave a double-time response. Several researchers concluded that the faster tempi produced greater accuracy than the slower ones (Williams, 1932; Jersild and Bienstock, 1935; Christianson, 1938; Petzold, 1966; McDowell, 1974; Kaplan, 1977). This held true for normal subjects, and in Kaplan's study the EMR subjects showed the same trend.

Smoll and Schutz (1978) continued Smoll's earlier work (1975) in the investigation of rhythmic motor performance and the influence of preferred tempo. Their sample consisted of two hundred college undergraduates. They measured both spatial and temporal accuracy in an arm swing motion, moving the extended arm at the shoulder from a vertical to horizontal position and back. While holding a light mechanical arm attached electronically to a digital printer, subjects responded to an audio-visual stimulus (a short tone and a blinking light) at a tempo that each had chosen as comfortable. The researchers found variability of tempo to be less at faster tempi. They also related a very low correlation between preferred tempo and temporal accuracy, measured as the deviation from the stimulus beat. They considered that these two performance attributes were independent of each other, thus the influence of preferred tempo on rhythmic accuracy was unclear and needed further investigation.

Kuhn (1974) found that increases in tempo were not as readily discriminated as decreases in tempo. Further, a later study revealed that musically trained subjects from first grade to college undergraduates increased performance (clapping) tempi significantly. Their performance was measured during a period that continued for a specific time interval after the 90 beat/minute stimulus ceased (Kuhn and Gates, 1975). Earlier research by Williams (1932) suggested that subjects tended to anticipate the beat rather than delay. In his study of non-major college band musicians Drake (1968) concluded that there was a marked tendency to "shorten beats or play faster than a given, or required beat while performing musical durational notation."[10] The findings of Petzold (1966) supports this conclusion.

Kaplan (1977) reported, from her review of the pre-recorded materials that accompanied the major elementary music texts, that no particular tempo emerged as one considered by the various authors as most suitable for elementary school learning. However, the range of 77-108 beats/minute, identified as Andante, appeared most frequently.

Kuhn (1974) suggested the following from his studies of tempo discrimination: a tempo of 90 should be used for slow examples with subjects of varying ages and musical training (He had used 60 as the slow tempo in testing professional musicians.); examples for inexperienced subjects should be twenty seconds long; and actual music should be used, rather than non-musical stimuli.

Other Related Concerns

In the course of their research and writings, some authors have made miscellaneous, but relevant, points about conducting investigations in the area of rhythmic behavior. Rainbow (1977) suggested that the performance of a steady rhythmic beat may be one of the most difficult tasks for children, and even adults, to learn. From this study of normal four-to-five-year old children, he concluded that vocally chanting a rhythm was more easily and accurately completed than stepping or clapping.

Bentley (1966) stressed the point that musical tests should give several practice examples so that the task itself is understood; he also suggested that comparing stimulus events of varying lengths can be confusing to a child.

In relation to testing handicapped subjects other researchers have suggested that ample and simple example items for performance should be given (McLeish and Higgs, n.d.; Bixler, 1968; Kaplan, 1977), and more than usual encouragement may be necessary (Walton and Begg, 1955; Kaplan, 1977.)

Relationship of Intelligence to Rhythmic Skills

The question of whether rhythmic skills are closely related to intelligence is not clearly answered by the literature encountered by this researcher. In an early study by Jersild and Bienstock (1935) IQ and rhythmic performance scores, measured in walking and clapping, correlated variably, though most correlations were positive. Wight (1937) also found "Rhythmization", the ability to reproduce rhythm patterns, and IQ both related to motor coordination, measured by tapping speed in handicapped children.

A recent look at rhythmic perception by Lienhard (1976), through discrimination of sameness and difference in pairs of rhythms, showed that IQ accounted for the largest portion of variation (13.23%). The subjects were mentally retarded, with an average age of sixteen years and a mean IQ of forty-six.

Kaplan's study (1977) may support the view that intelligence influences rhythmic performance, in that her groups matched by mental age, but differing in chronological age, did not show significant differences in most areas.

On the other side of the question, Bentley (1966) concluded that there was a low correlation between general musical ability and IQ in normals, and Bixler (1968) stated that he found a low correlation between Gordon's Musical Aptitude Profile and four IQ measures in EMR subjects. Rhythm was correlated to mental age at .17. In early research, Sievers (1932) and Christianson (1938) found IQ to not be significantly related to motor synchronization skills. More recently Langille (1977) studied normal second graders and concluded that IQ did not have a significant effect on rhythmic pattern perception.

Relationship of Rhythmic Skills to Other Areas of Human Behavior

While research findings seemed sparse in establishing the benefits of musical and rhythmic skills as precipitants to gains in other skill areas, the idea has received some attention and peripheral support from researchers and other experts in the field of development for the handicapped.

Langille (1977) reported findings that rhythmic pattern perception and auditory discrimination skills were related to reading vocabulary and comprehension. Wolff (1979) noted that musical instruction did not effect reading scores, but did effect math, creative thinking, and perceptual motor scores in high achievers and males in the first grade.

Ross, Ross, and Kuchenbecker (1973) stated their collective view on the importance of rhythmic skills to the EMR child:

> The ERM child's difficulty in activities such as jump-rope and pegboard races is frequently due to his inability to maintain a rhythmic tempo rather than to inability to perform the specific responses of jumping in place or loading pegs. The ability to respond rhythmically is of considerable importance to the psychological well-being of the EMR child; it is prerequiste to success in play activities, sports, and social dance; it helps to prevent fatigue and promote a feeling of control; and it is of particular importance for successful performance in the vocational tasks such as typing, machine work, and small parts assembly that the EMR child is likely to perform in adulthood.[11]

Dr. John S. Rowlson, in a personal interview, commented about his clinical observations of mentally retarded clients in the therapeutic work environment of Bretton Square Industries. He stated that it appears that when rhythmic flow in a manual job function is interrupted, the efficiency is disrupted. In the physical efforts of those who produce in quantity, there is a fluidity of movement. There are fewer wasted motions and less deliberation between movements.

Rowlson pointed out two skill areas necessary for the successful performance of the manual jobs at Bretton Square. The first is the mechanics of the job, and the second is timing. For example, in mopping, a figure eight pattern is taught, and rhythmic execution becomes a part of the skill. In a paper collating task, a sense of rhythm is helpful. On the stamping machine, the most successful clients demonstrate rhythm.

The ninety mentally retarded adults who work at Bretton Square Industries range in age from twenty-six to seventy-three and in IQ from approximately 16-20 to 88. All clients work in a large, open room. On several of the jobs the machines impose a constant, timed sequence of mechanical sounds. On many days the staff have reported that the shop "hums" auditorily and behaviorally as the separate job processes begin to coincide. At these times conversation proceeds smoothly and behavior problems are fewer.

At the clients' request, music is played in the work environment throughout the day. It has been observed that when the volume becomes too loud, behavior problems increase. This is believed to be the result of the music having the effect of additional noise. When the shop is under stress, the music is often felt to be annoying.

With regard to music choices, clients found soothing music to be boring and moderately stimulative music to be most preferred. Some of the clients use personal radios with earphones while working, and the motor rhythm of their job performance seems to be influenced by the music to which they are listening. (Rowlson, 1983)

In the area of speech skills, Gibson (1978) referred to the work of J.B. Share in the following quote on the importance of motor control skills:

> It can be fairly contended that lateralization and motor control delay are related to delayed speech (Share, 1975), whether the subject is Down's or not. Any procedure which would hasten motor coordination, such as patterned exercise, might advance the establishment of cerebral dominance and therefore of speech readiness. These possibilities have not been adequately explored for the DS child.[12]

Down's Syndrome

Identification of the Syndrome

In his book, Down's Syndrome (1978), David Gibson has enumerated the viewpoints and research that have contributed to the currently accepted description of this disorder, originally called mongolism, first identified by Langdon Down in 1866. The condition is a chromosomal abnormality that is identified by both clinical manifestations and by abnormal genetic configurations.

Clinical diagnosis of DS is made through the observation of all or some of the following somatic signs, often referred to as the thirteen cardinal indices of mongolism:

1. High cephalic index
2. Abnormal nostral direction
3. Abnormal toe spacing
4. Short fifth digit
5. Curved fifth digit

6. Square hand
7. Epicanthic fold
8. Fissured tongue
9. Simian crease
10. Single fifth flexion
11. Abnormal ear
12. Adherent lobule
13. Abnormal heart

Genetic determination of the disorder is made through genetic testing of body cells (karyotyping) that reveals the presence of extra chromosomal material. Three karyotypes have been identified: standard trisomy, the most common, the result of three number 21 chromosomes instead of two; translocation trisomy, the result of some chromosome 21 material attaching to chromosome number 15; and mosaicism, the result of some abnormal and some normal cells in one individual.

Mental Development

The developmental characteristics of DS seem to follow a generally predictable pattern. However, Gibson (1978) cautions against the temptation to overgeneralize: "Despite the stereotypic uniformity of the syndrome, the most striking feature is its developmental variability."[13]

During the first few months of life DS infants show near normal mental growth. While subsequent mental growth follows the usual developmental sequence, the rate falls behind that of their normally developing CA peers (Carr, 1970; Gibson, 1978). Mental growth has been known to continue as long as age twenty, but usually at about age eleven it ceases, and a gradual deterioration begins to occur. This decline takes the form of pre-senile dementia and frequently is exacerbated by Alzheimer's Disease.

DS mental growth appears to proceed in plateau stages, even more than for normal children. These stages are:

Growth Stage	I	1½-4 years	CA	reaching 17 months MA
Growth Stage	II	5-9 years	CA	reaching 31 months MA
Growth Stage	III	11-12 years	CA	reaching 40 months MA[14]

The second stage is generally the limit of expected mental growth, covering a range of two to three years of MA for the majority of DS.

Early studies found the majority of DS to test in the 20-40 IQ range, with the next largest group falling below 20. IQ's as high as 66 occurred infrequently. While most studies were conducted on institutionalized DS, Wallin (1944) began to look at DS children in the community and to challenge earlier conclusions. Gibson (1978) noted that the variability of results between studies, attributable to differences in age at testing, nutritional and health status and institutional selection bias, had not been explored by any of the early investigators. Consequently, reliable conclusions as to dimensions of intelligence for DS were not possible, even up to 1950.

More recent investigators sampled more community and institutionalized DS and generally reported a somewhat higher IQ range. Quaytman (1953) found that while 75% of her home-based sample were below 50 IQ, 25% were above, the majority of them still below 70 IQ. Cornwell and Birch (1969) found most of their community based sample fell between 23 and 69 IQ. They noted that higher IQ's occurred more often in younger rather than older cases. In summary, Gibson (1978) said, "the distribution of IQ for DS seems to centre at mid-imbecility (TMR), with a large minority grouped in the custodial category and a not-so-large minority within the educable class."[15]

The beginning development of conceptual-symbolic mental skills appears to be a barrier to further mental growth for the vast majority of DS persons. Most do not develop the ability to use abstract thinking processes. While the evidence is not totally conclusive, the available statistics point to a generally higher intelligence in female DS than in males. Females also have a higher infant mortality rate, and males seem to be more susceptible to secondary illnesses as they develop, circumstances which may result in the survival of healthier, more intelligent females.

Physiological Characteristics

Common physiological deficits in the syndrome, in addition to their premature neurological deterioration, include a weak cardiovascular system, reduced sensory functioning, and hypotonia, a generalized state of muscle flaccidity. Susceptibility to respiratory infections is secondary to structural characteristics of small oral and nasal passages and weak diaphragm muscles. There is a generalized condition of premature physical aging, accompanying the early onset of progressive intellectual decline.

In physical stature the DS person has shorter than normal bone structures, especially noticeable in distal ends of the long bones of the arms and legs, as well as those of the hands and feet. They are shorter in overall height, a characteristic that shows an increase in proportion to normals as they grow older. In the twelve to eighteen-year-old group, 73% are below normal height. Based on height, many DS individuals are overweight.[16]

Smith and Berg (1976) reported early surveys of mortality in DS. A 1958 study showed that 30% died by one month of age and 50% by one year. Later reports still indicated that DS death rates are highest during the first four to five years of life. By 1970 approximately two-thirds of DS children lived past age ten. A major factor in DS mortality is the high incidence of congenital heart disease (60%). Average lifespan has increased from nine years of age in 1932 to over thirty by a 1973 survey; the upper expected age is around fifty-five years.[17]

Personality

In personality traits DS have been characterized as having cheerfulness, good disposition, obedience, and independence on the positive side, and having communication disorder, stubbornness, short attention span, attention seeking and easy fatigue on the problem side. A 1966 institutional study in Arizona and Washington indicated that DS exhibited significantly less aggressive maladaptive behavior than other mentally retarded patients (Moore, Thuline, and Capes, 1968).

> Negative behavioral changes, detected as the child grows older, seem to coincide with two developmental events; a failure to bridge concrete to conceptual styles of intellectual expression, and an absence of language skills appropriate to the expectations of advancing age. Both the ability to abstract and relate interpersonal events, and a suitably matched advance of communication skills, are critical to positive growth and maintenance.[18]

Though not observed in all cases of DS, Gibson stated the following concensus view by the writers he reviewed regarding characteristic personality development:

> . . . the placid, sensorially insufficient infant becomes an emotionally intact and outgoing child who turns subsequently into a sullen adolescent and finally faces premature aging and marked behavioral deterioration in early adulthood.[19]

The nurture of a home environment over that of an institutional setting seems to be a significant factor in personality, as well as total development (Carr, 1970).

Speech and Language

DS speech often shows a defect, particularly in the articulation of speech sounds, and a generally nasal, breathy, hoarse voice quality. This is thought to be a result of structural traits including a shortened oral cavity, dryness and protrusion of the lips and tongue, and underdevelopment of the sinuses and nasal passages.

Speech and language development is also influenced by characteristic hearing and visual impairments, found to be higher than normal in this syndrome. Carr (1970) reported a study by Lyle in 1959 in which DS individuals made less progress than other mentally retarded persons in speech when moved to a more stimulating environment.

In language use, DS persons show

> . . . a preference for certain parts of speech over others [nouns], a better verbal understanding than word use, a tendency to emphasize the first consonant and vowel sounds of words and a propensity to communicate with a minimum of verbal complexity.[20]

In Gibson's (1978) view the DS persons' language and communication patterns are caused by a combination of mechanical (structural), sensorimotor, and central nervous system anomalies, the last of which is in a deteriorating process as the first two show some improvement with growth. Other possible factors include slow reaction time, depressed arousal potential, and reduced attention span.

Sensorimotor

In sensorimotor areas the DS person shows the strongest performance in the areas of visual decoding or reception (understanding pictures of low verbal content) and motor encoding or expression (conveying thoughts by gesture), with the most sensory deficit in the area of auditory channelling. This appeared clearly in a 1965 study comparing DS to each other by Bilovsky and Share as reported by Gibson. They are also described as having good motor strength and superior early self-help skills. He points out that this evidence is most convincing for DS children prior to late adolescence and adulthood. Motor potential in DS appears good in infants but erodes rapidly from the norm after the first year.

It is a general concensus from most research that reaction time in DS is slower than normal as well as slower than that of other non-DS mentally retarded people. Gibson (1978) pointed out, however, that the conclusions as to cause of slow reaction time are quite variable, including:

1. Cerebellar originated hypotonia
2. Conceptual handicap (cognitive)
3. Sensory or perceptual handicap (auditory discrimination)
4. High arousal thresholds (to stimulate attention and drive)
5. Motor impulsivity differences

Davis and Kelso (1982) compared normals to DS and concluded that the neuromuscular system employed in gross motor movement was similar for both groups. However, they reported a notable difference in response to changes in weight loads on static muscle/limb position. DS showed a greater degree in the angle of overshoot when adjusting to weight added to a mass held steady by the subject's finger.

With regard to discrimination skills, Gibson (1978) reported a concensus in the literature that DS people are lower in ability than other mentally retarded for stereognostic, kinesthetic, and tactile shape discrimination and possibly for auditory-vocal channelling. However, they are claimed to be equal to or higher in ability than other mentally retarded for visual-stereognostic, visual-tactual discrimination, and for visual exploration potential. Attention span difficulties, related to high distractibility and impulsivity, is also generally accepted regarding DS, though not appreciably more than for non-DS retarded.

The total picture of the DS person's traits and abilities seem to rest on an interaction of effects from three major areas: central nervous system deficits, peripheral sensorimotor characteristics, and unique physiological (structural and medical) conditions.

Studies of Rhythm and Motor Skills in DS

Early opinions on the rhythmic abilities of DS persons held that they possessed a "marked sense of rhythm" (Tredgold and Soddy, 1956) and a heightened sensitivity to music in general (Shuttleworth, 1900; Brushfield, 1924; Wallin, 1949). Though more recent research has not supported this belief (Cantor and Girardeau, 1959; Fitzpatrick, 1959; Peters, 1970; Frith and Frith, 1974), there exists the lay impression that dance, rhythm, and melody skills are "inborn" in DS (Gibson, 1978). Even many non-music health professionals still attribute a high level of rhythmic ability to DS persons in general.

Martha Peters (1970) studies DS children in comparisons with normals matched for chronological age, IQ, and mental age. When matched by mental age, DS of sixteen years of age were compared to six-year-old normals, and six-year-old DS were compared to three-year-old normals. The DS mean IQ was 38.

She measured musical sensitivity by responses to musical variables such as stimulative and sedative music; music that was predominantly harmonic, melodic, rhythmic, or dissonant in character; orchestral and piano music; and clapping and singing activities. In her findings she noted a lower score of musical responsiveness in DS, though statistical significance was not achieved. DS subjects scored lower in imitation skills when matched with normals of the same chronological age or of the same mental age. DS subjects of all ages tended to respond most like the very young normals. In rhythmic abilities the sixteen-year-old DS tested similarly to three-year-old normals. All groups showed a high preference for rhythmic music and little preference for singing (except for normal six-year-olds). For clapping activities younger DS showed a lower responsiveness and older DS showed higher. The study was difficult to evaluate as the test appeared to be quite short, little data was reported, and the definitions of the variables were not clear.

In 1959 Cantor and Girardeau reported their investigation into the DS person's ability to discriminate and identify fast and slow tempi. The fast (120 beats/minute) and slow (88 beats/minute) stimuli were provided by metronomes placed out of the subject's sight. Once the subjects demonstrated verbally that they recognized and could label the two rates, the testing was conducted. Half of the subjects were instructed to tap with one finger on the table as they listened to each of the sixty tempo items, while the others were instructed to simply listen. Forty-four DS and twenty-four normals of nearly matched mental age were tested. Fifteen of an original group of fifty-nine DS subjects were eliminated, seven due to unintelligible speech and eight due to lack of cooperation.

While the DS subjects scored significantly better than that expected by chance, the normals discriminated significantly better than the DS. The Tapping groups did no better than the No-Tapping groups. However, the researchers noted that very few of the subjects were capable of tapping in reasonably good time, and that the activity may have interfered rather than facilitated accurate tempo discrimination.

Fitzpatrick (1959) conducted two experiments concerning the rhythmic motor skills of severely retarded subjects. The first study, designed to simply explore the rhythmic nature of the DS person's movements, involved the repeated bilateral folding of two levers from a vertical to a horizontal position. Twenty subjects of the same mental levels (4.1 years mental age), ten DS, and ten unclassified mentally retarded hospital patients, performed the movement for twelve periods of ten minutes each. Periods were divided into two-minute segments, alternately accompanied by a metronome ticking at 110 beats/minute and without any accompaniment. The speed of folding was measured and compared to the metronome tempo. Half time and double time rates of response were given credit.

Fitzpatrick found no significant difference between the two groups, either in output or in regularity. The intervention of the metronome had no benefit on performance, but actually tended to make responses more erratic. The experimenter interpreted the results to suggest that DS individuals do not have particularly strong rhythmic skills.

Fitzpatrick's second experiment involved severely impaired hospitalized patients, non-DS, and the effectiveness of three different interventions to aid their performance on a group work task. They worked in groups of three on a task of folding large pieces of polyethelene in a prescribed manner. The three conditions under which they worked were: (1) at their own pace, (2) with music and, (3) with a caller chanting the instructions for the job. The third condition proved to be significantly better at improving their work output.

Frith and Frith (1974) studied specific motor disabilities in DS subjects by using comparison groups of normals and severely subnormal autistic subjects matched first for mental age and then for performance on a rotary pursuit tracking task. The sample was structured in this manner so that performance effects could be better sorted out as attributible to DS in particular rather than simply to their subnormal mental conditions. Two motor tasks were used in the testing: (1) rotary pursuit tracking, which requires the learning and usage of motor programs for successful execution of the skill and (2) tapping, which involves little or no learning. It was anticipated that performance of these two tasks would help permit the distinction between impairments of performance and impairments of learning.

Rotary pursuit tracking is measured by the amount of time a subject can keep a photoelectric cell, attached to his/her finger, on a patch of light moving in a circle on a flat surface. Subjects tracked for two periods of three minutes, with a five minute rest in between.

Performances by DS subjects showed a mean tapping speed (113 beats/minute) significantly slower than either of the other two groups. They had higher tapping variability associated with higher tapping rate; the other children did not. DS also showed no improvement in tracking after the five minute rest; the autistic children did.

Frith and Frith concluded that DS persons maintain motor control by responding to immediate perceptual feedback rather than by developing motor programs by which rapid, regular movements can be anticipated and accurately followed. This is a difficulty compounded by generally slow reaction time, as well. The researchers conclude that "mongol children should do relatively well in motor tasks requiring slow movements following no predetermined course but relatively badly at tasks involving fast and regular movements."[21]

Summary

Rhythmic synchronization has been of interest to researchers for several decades. It has been studied both by inference from observation and by formal testing using electronic instrumentation, mostly with normal populations. Performance, rather than discrimination, measures are generally recommended to test this motor skill area. The findings indicate that synchronization skills are not fully acquired until approximately age seven, and that, in the tempo range of 60-182 beats/minute, subjects tend to synchronize better at the faster tempi. It is not clear from the research studied whether performance is better at a tempo chosen by the subject.

Down's Syndrome individuals are generally in the TMR range of intellectual functioning and have motor and sensory deficits that most likely affect their rhythmic skills. They are stronger in visual than auditory discrimination. Despite their acknowledged attraction to music activities, the research literature does not support the idea that they possess outstanding rhythmic skills.

CHAPTER III

METHODOLOGY

Sample

The sample studied in this investigation consisted of subjects identified as having Down's Syndrome. All lived in community-based foster care or group homes, or at home with their parents. The majority were involved in school special education programs (if under twenty-six years of age), or in community mental health activity or work programs (if over twenty-six years of age), as prescribed by Michigan laws on public education for the handicapped and the mental health code. They ranged in age from eight to forty-eight years old, with a mean age of 21.2 years. Twelve were males and nine were females. Of the twenty-one subjects, IQ scores were available on nineteen; the mean IQ was 43. Thus, the majority of subjects were in the TMR classification, with four testing in the low EMR range and one at the top of the severely mentally retarded range (See Appendix A for a breakdown of the demographic figures on subjects.)

Any potential subjects who had a diagnosed major motor, physical, or health impairment in the categories that follow were eliminated from the study: cerebral palsy, muscular dystrophy, multiple sclerosis, severe hearing impairment, legal blindness, or amputation, paralysis or deformity of the upper extremities.

Inasmuch as musical training could alter the level of rhythmic ability demonstrated by the subjects, the study limited the sample to DS individuals who had no specific formal training in music, such as individual music lessons on a single instrument or voice for a year or more. It was thought that participation in school music classes or music therapy treatment in which motor development was not a specific goal would not exert a significant influence upon the results of this study, since random assignment to experimental conditions would control for varying musical experiences among the subjects.

Many of the school-aged subjects were drawn from the Ingham Intermediate School District facility for the handicapped in Mason, Michigan. The rest were contacted through their participation in Greater Lansing community music groups for the handicapped and through the Michigan State University Music Therapy Clinic. In order for subjects to participate in the study, they and their parents or guardians had to agree to come to the testing site on the campus of Michigan State University.

Design

The design for this study incorporated a one-way analysis of variance to test the significance of differences between the means of three different treatment groups. Each of the twenty-one DS subjects were randomly assigned to one of three groups. Each grouping represented an experimental condition (treatment) in which the subject was tested at one of the following tempi:

1. 90 beats/minute (Group A)
2. 150 beats/minute (Group B)
3. a tempo spontaneously chosen by the subject (Group C)

The random selection for each group was achieved by assigning each subject to one of the three conditions in turn as the testing proceeded. This was intended to equalize the groups so that the main effect of the independent variable (tempo) could be observed through the measurement of the dependent variable (synchronization score) and compared among the three groups. Data for the other independent variables under investigation (intelligence and age) were collected as IQ scores from the most recent psychological testing available and as dates of birth for each subject. These scores were correlated to synchronization scores to study the relationship between intelligence and synchronization skills and between age and synchronization skills.

Setting and Procedure

Each subject was tested one time, during a fifteen-minute music session. The experimenter conducted all of the testing sessions on a one-to-one basis with each subject. The setting was a well-lighted, quiet, carpeted, partitioned laboratory. A table with the electronic measurement equipment was at one side of the medium-sized room, and the technical assistant was seated next to it. An electric piano was at the side of the equipment and was played by an additional assistant during only the "tempo of choice" condition. The subject and experimenter sat in chairs facing each other, with the subject's back to the equipment.

The rhythmic motor task used to test rhythmic synchronization consisted of playing with a single mallet on a freestanding, twelve-inch, tunable drum placed between the subject and experimenter. The playing surface was slightly below waist level for the seated subject. The mallet was offered to the subjects at the midline and each subject played with whichever hand he/she preferred. The subjects were instructed to play on the beat of the music they would hear during the training and testing segment of the session.

The testing session followed the four-step format described below:

1. A warm-up musical activity of easy movement and body percussion to help acquaint the subject with the experimenter and put the subject at ease
2. A set of four training examples to teach the subject the drum playing task to be performed with music at the appropriate tempo:
   - Example a) Experimenter demonstrated the drum playing task; subject observed
   - Example b) Experimenter and subject both played on the same drum; total task was modeled and cued by the experimenter
   - Example c) Experimenter and subject both played; task was modeled by the experimenter at the beginning, but faded out about one-half of the way through; only verbal encouragement used thereafter
   - Example d) Only subject played; verbal encouragement used if necessary
3. A test item at the experimental tempo, the subject alone playing the drum
4. An untested activity of the subject's choice, to wrap-up the session (e.g., sing a favorite song, play an instrument, etc.)

(See Appendix B for an example of the narration used in instructing each subject throughout the testing session.)

After the first seven subjects were tested a brief segment of exploratory drum playing and a short tapping test of the subject's fastest speed were incorporated immediately prior to step 2. This procedure resulted from a question regarding the capability of some subjects to actually play as fast as 150 beats/minute. This was initiated to help explain the possibility of extreme deviations from the beat at the fast tempo.

The recorded musical stimulus consisted of the following events, all at the given tempo: eight beats of metronome clicks; eight beats of metronome clicks with "one, two, three, four, one, two, ready, go" spoken over them; and either (a) thirty-two beats of piano music at 90 beats/minute (21.3 seconds in length) or (b) forty-eight beats of piano music at 150 beats/minute (19.2 seconds in length). All of the music used was composed and performed by a professional pianist to provide a strong rhythmic pulse on every beat, in popular harmonic style, but with only a few passing notes played for musical continuity on the subdivisions of the beat.

The tempo of choice condition was constructed in the following manner: for each of the four training items and for the test item, the subject was directed to begin playing at any speed he/she wanted; a pianist assistant set a metronome at the resulting speed; the experimenter asked the subject to stop playing and then counted "one, two, three, four, one, two, ready, go" with the metronome; the pianist assistant played a short composition of a character similar to those mentioned above with the tempo of the metronome as the standard for the test item, as the subject played on the drum. The sixteen beat musical composition was played twice through for tempi chosen that were

120 beats/minute or lower, and three times through for tempi above 120 beats/minute. (See Appendix C for the musical examples used in the three conditions.)

For the present research a moderately slow tempo of 90 beats/ minute was chosen to avoid the tendency to subdivide very slow tempi and to provide a feeling of musical continuity in the music which was composed purposely to emphasize only the beats, with very few extra notes between them. The tempo of the subject's choice is an experimental condition believed by this researcher to be influential in the success of motor synchronization for DS individuals. This belief has arisen from clinical observations in which DS people appear to maintain steady beats, but not necessarily at the speed of the musical stimulus at hand.

Measurement

The measurement apparatus used in the study was a two-channel chart recorder, model 1200, manufactured by the MFE Corporation of Salem, New Hampshire. It was chosen for its accuracy and permanence of record. It registered each the stimulus and the response through the deflection of a stylus on a paper roll moving at a rate of 100 mm/second. At that rate, it gave an accurate measurement to within .01 second. One channel made a record of the music stimulus, either played on the cassette tape recorder and fed in electronically by way of an amplifier, or played on the electric piano and electronically fed directly into the chart recorder by way of a small, ceramic crystal microphone taped inside near the head of the drum.

Synchronization scores were calculated to the nearest hundredth of a second in two ways: 1. as the mean deviation of the subject's response beat lengths (RBL) from the stimulus beat length (SBL) at the given tempo and 2. as the deviation of the subject's mean RBL from the SBL of the given stimulus. The measurement of responses began after the first eight beats of music, in order to avoid penalizing subjects when making any necessary adjustments to regulate their initial motor responses. The subsequent twenty-four beats were measured.

Synchronization score category 1 was determined for each subject by subtracting the SBL from each RBL in the tested twenty-four beats of music. The highest and lowest deviations were discarded and the mean deviation was computed from those remaining. Absolute deviations (without regard to positive or negative sign) were used in this computation so that deviations on opposite sides of the SBL did not cancel out each other's value.

Synchronization score category 2 was determined by subtracting the SBL from the subject's mean RBL. Figured in this manner, a negative score indicated a beat length shorter than the standard, and therefore indicated a response that tended to rush ahead of the beat on the average. A positive score indicated an elongated beat length, and consequently a response that lagged behind the beat on the average.

By the same principle, the group mean synchronization scores in category 2 indicate the general direction of error in synchronization within each tempo condition. Because of the closeness and small size of the scores, all subject and group mean scores were expressed in thousandths of a second after computations were completed.

A tolerance of $\pm.01$ second was removed from each score to allow for the average error found in the recorded stimuli at both 90 beats/minute and 150 beats/minute. For the tempo of choice, the tolerance was calculated separately for each subject's test, as the musical stimulus was played and recorded live each time. The tolerance in that tempo condition ranged from $\pm.01$ to $\pm.02$ with a mean error of $\pm.01$.

Special Considerations

Testing of handicapped subjects can create special concerns about reliability and validity of the testing method. The following factors were considered particularly important: the subjects may be inhibited, frightened, or uncooperative due to the strangeness and unfamiliarity of the setting, the experimenter, or the apparatus used; and the handicapping condition may complicate the conveyance of instructions and the subsequent performance by the subject (Bixler, 1968), especially if communication or attention span are impaired (Cantor and Girardeau, 1959). Consequently, for this type of research, testing procedures must be clear, uncomplicated, and well-paced, and testing media must be interesting and motivating. Additionally, the setting must feel supportive, congenial, and comfortable for the subject.

This study attempted to anticipate and accommodate for these particular characteristics involved in testing the handicapped through these provisions:

1. The musical stimuli used emphasized the beat clearly and strongly
2. The music was rhythmic and popular in style to help maintain attention and interest
3. Instructions proceeded in small progressive steps, primarily through demonstration, with a minimum of verbal information
4. The procedure kept the subject active throughout most of the session, which was short (fifteen minutes)

5. Encouragement and support, both verbally and non-verbally, was maximized as appropriate, beginning with an easy, comfortable activity and ending with an activity of the subject's choice, both of which were unencumbered by concern for measuring the behavior
6. Playing the drum, generally a popular and motivating instrument, was the media for testing motor response; the drum had no obvious testing apparatus attached, and the subjects needed no distracting apparatus attached to them

Pilot Testing

The testing procedure and the paper recording device were pilot tested. The experimenter's responses to the stimulus were used to determine preliminary adjustments of the apparatus and to practice the scoring techniques. Following this, a mentally retarded subject was tested on the complete procedure, using the 90 beats/minute tempo for the testing segment. Finally, a university percussion major was tested on all three tempo conditions.

Analysis

A one-way analysis of variance was performed on the data to determine if there were statistically significant differences in the mean performance scores of the experimental groups. That the effects of the tempo variable could be attributed to chance was determined through this analysis.

To study the relationship between IQ and rhythmic synchronization, a rank-order correlation was calculated on the synchronization scores and the IQ's of nineteen of the twenty-one subjects for whom intelligence testing was available. A rank-order correlation was also calculated on synchronization scores and chronological age in months.

Summary

Twenty-one DS subjects, averaging 21.2 years in age and 43 points in IQ, were each randomly assigned to one of three experimental tempo conditions: 90 beats/minute, 150 beats/minute, or choice of tempo. They were tested in the performance of a motor synchronization task that consisted of playing a drum to a musical stimulus of piano music. The stimulus and motor responses were recorded on a two-channel chart recorder. Deviations of the response beat length (RBL) from the stimulus beat length (SBL) were calculated and the mean differences were compared across experimental conditions and in relation to IQ and age. A one-way analysis of variance was used to determine the statistical significance of the results, and rank-order correlations were computed on the synchronization scores and both IQ and age.

CHAPTER IV

RESULTS

Findings

This study measured rhythmic synchronization response to an external stimulus in DS persons by recording and comparing the response beat length (RBL) of the subject to the stimulus beat length (SBL) of music played at one of the three tempo conditions. The raw data and demographic information for each subject and group are included in Appendix A.

Subject #7, in Group A, responded at an almost perfect double-time tempo in the testing. The mean RBL was .318 second as compared to the SBL of .635 second. This was actually faster than the tempo demonstrated in the tapping test in which the subject was asked to play as fast as possible (beat length of .368 second). Due to the small sample size, the resulting scores for this subject inflated the Group A figures to a degree that appeared unrepresentative of the group's actual performance. This circumstance also greatly increased the differences between the mean scores of Group A and the other two groups, possibly giving the illusion that this experimental condition had a greater effect on performance than was reasonable to imply. Therefore, rather than assuming that the response was either highly synchronized but simply double-time or poorly synchronized, the subject's data were eliminated from the statistical analysis.

Due to differences in tempo calibration between the metronome used as a standard when recording the musical stimuli and the tempo as calculated from the chart recorder, 90 beats/minute was actually 94 beats/minute, and 150 beats/minute was actually 155 beats/minute. For the purposes of reporting and discussion, however, they will continue to be referred to as 90 and 150 throughout the paper.

The tapping speed test that was incorporated into the session for the last fourteen subjects revealed a range of tempi from 114 to 337 beats/minute. The purpose of this test was to verify that the subjects were, in fact, capable of responding at or above the speeds requested of them. Only one subject, #14, demonstrated a maximum tempo that was slower than that of the experimental condition in which the subject was placed. This same subject responded during the synchronization testing with a shorter beat length, and consequently a faster tempo, than that imposed by the external stimulus.

The mean deviation of the RBL's from the SBL was calculated for each subject (synchronization score category 1), as well as the deviation of each subject's mean RBL from the SBL (synchronization score category 2). In Table 1 the group means for these two synchronization categories are given.

A one-way analysis of variance was computed on the scores which consisted of the mean deviation of the RBL's from the SBL (score 1). The differences in the mean scores between the tempo conditions were found to be statistically significant at the .01 level of confidence (see Table 2.)

The Tukey multiple comparison test was subsequently performed on the data to determine between which pairs of groups the means were

TABLE 1

GROUP MEANS FOR DEVIATIONS OF RESPONSE BEAT LENGTH (RBL)
FROM STIMULUS BEAT LENGTH (SBL)

Synchronization Score Category	Tempo Condition Groups		
	A 90 beats/minute	B 150 beats/minute	C Choice of tempo (mean)
Stimulus Beat Length	.635 second	.381 second	.388 second
1. Mean deviation of the RBL's from the SBL	$\overline{X}_A$ = .055	$\overline{X}_B$ = .030	$\overline{X}_C$ = .013
2. Deviation of the mean RBL from the SBL	$\overline{X}_A$ = -.030 *	$\overline{X}_B$ = -.006	$\overline{X}_C$ = -.001

* Negative sign indicates that the RBL is shorter than the SBL.

TABLE 2

ANALYSIS OF VARIANCE FOR THE MEAN DEVIATION OF THE RESPONSE BEAT LENGTHS (RBL) FROM THE STIMULUS BEAT LENGTH (SBL)

Source of Variation	SS	df	MS	F	p
Between Groups	.0059	2	.0030	7.5	$<.01$
Within Groups	.0073	17	.0004		
Total	.0132	19			

significantly different. The results of this computation, labeled the honestly significant difference (hsd), showed significance at the .01 level between groups A and C only (see Table 3).

Rank-order correlations were computed between the mean deviation of the RBL's from the SBL (score 1) and intelligence, reported as IQ scores, and age. The correlation coefficients for each of the three groups can be found in Table 4. None of the correlation coefficients reached statistical significance.

Review of Research Questions

1. To what degree of accuracy can a DS person synchronize motor responses to a regularly occurring external auditory stimulus (the beat of music)?

Synchronization was measured by comparing the beat length of a recurring stimulus. In actual time the individual mean deviations were quite small, ranging from .080 second shorter to .055 second longer than the stimulus beat length. These deviations were in excess of the

TABLE 3

TUKEY MULTIPLE COMPARISON OF HONESTLY SIGNIFICANT DIFFERENCE (HSD)

Absolute differences between group means			Critical values for hsd
	$\overline{X}_A$	$\overline{X}_B$	
$\overline{X}_B$	.025	____	hsd = .028 (p = .05)
X_C	.042*	.017	hsd = .036 (p = .01)

*Significant at the .01 level

TABLE 4

RANK-ORDER COEFFICIENTS RESULTING FROM CORRELATIONS OF MEAN DEVIATION SCORES WITH IQ AND AGE

Measurements Compared	Tempo Condition Groups		
	A 90 beats/ minute	B 150 beats/ minute	C Choice of Tempo
Mean deviation (Score 1) and IQ	r_s = .43 n = 6	r_s = .06 n = 6	r_s = -.51 n = 7
Mean deviation (Score 1) and age	r_s = -.37 n = 6	r_s = .25 n = 7	r_s = .49 n = 7

allowed error tolerance present in the stimulus beat length. While the small deviations give the appearance of quite accurate synchronization, in practical application they can have an asynchronous effect. For example, at 90 beats/minute, a single beat is .635 second in length. If the average response beat length is .080 second shorter, over a series of eight beats more than a whole beat is gained (a total of .640 second). Consequently, after only four stimulus beats, if the deviation is consistent, the response will be occurring half-way between beats, rather than close to the incidence of the stimulus beat. This was a pattern observed consistently in the DS subjects tested.

2. Do DS persons demonstrate similar characteristics in motor synchronization?

As shown in Table 1, score 2, the group means indicate a tendency for each of the three groups to respond with mean beat lengths that are shorter, overall, than the stimulus beat length. This represents a general characteristic of responding ahead of, or faster than, the external beat in the DS subjects tested.

Of the twenty-one individual subjects, ten responded ahead of the beat on the average, four responded behind the beat, and seven responded in synchronization with the beat within the error tolerances allowed (See synchronization score 2, Appendix A).

3. Is motor synchronization ability in DS persons affected by the speed of the stimulus events (the tempo of music)?

The score differences in mean deviation of the RBL's from the SBL among the three experimental groups showed the greatest deviation, or error, occurring in Group A (90 beats/minute) and the least in Group C (choice of tempo). These findings suggest that, with a choice of tempo, DS persons synchronize more accurately than at either 90 or or 150 beats/minute. When mean deviation is compared as a percentage of the given SBL, Group A shows a deviation of 8.7%, Group B a deviation of 7.9%, and Group C a deviation of 3.4%. These findings are especially notable in view of the fact that the mean tempo chosen by subjects in Group C, 155 beats/minute (calculated from the mean SLB of .388 second), is very close to the given tempo for Group B.

4. Is there a significant relationship between motor synchronization ability and measured intelligence (IQ) and age in DS persons?

The findings do not support the possibility of a significant relationship between synchronization ability and IQ. Though non-significant, the correlation coefficients show a trend of decreasing relationship between IQ scores and synchronization accuracy from Groups A through C (see Table 3).

The relationship of age to synchronization scores was also investigated through a rank-order correlation (Table 3). These results were not statistically significant. However, the correlation co-efficients indicate a possibly increasing relationship between age and synchronization accuracy from Groups A through C.

Interpretations

Since the differences in group means of the three experimental groups were found to be significant at the .01 level, the superiority in performance of Group C, Choice of Tempo, is thought to be a meaningful finding. This suggests that the DS person would probably synchronize motor movements to an external stimulus more successfully when given a choice as to the speed at which the stimulus would proceed. Furthermore, from the data gathered it appears that on the average a

DS person would prefer a tempo in the area of 150 beats/minute. The choice of optimum tempo seems to be quite an individual matter, however, since the group tested at the 150 beats/minute did not synchronize as accurately as those who chose their own speed in the same average range of tempo.

The results of this testing do not support the notion that DS persons have a particular aptitude for rhythm, though these subjects clearly showed an attraction to music activities. The error in synchronization demonstrated in this study does not appear to be large, but it does appear to occur as a consistent individual motor response pattern in these DS subjects. Their playing is not characterized by erratic response; rather, it is marked by a tendency to shorten the given beat length and to play a small, but consistent, amount faster than the given tempo.

There is no new evidence, as a result of this study, that age or intelligence are substantially related to skills in rhythmic synchronization.

Summary

The results of the motor synchronization testing revealed statistically significant differences in the mean scores between experimental tempo conditions A (90 beats/minute) and C (choice of tempo). The DS subjects showed a tendency toward playing faster than the external stimulus beat, as reflected in the shorter mean response beat lengths. This appeared more notably in the slower tempo of 90 beats/minute. The group that was given a choice of tempo at which to play chose an average tempo of 155 beats/minute. This group deviated from the stimulus beat length less than the other two groups. While the deviations for most subjects were not large, they appeared fairly steady and consistent.

No significant relationship was observed between rhythmic synchronization skills and either IQ or age.

CHAPTER V

SUMMARY AND CONCLUSIONS

Summary

The Down's Syndrome individual has long been characterized as a person who is highly sensitive to music and skilled in rhythm. Recent research evidence does not lend strong support to this belief. However, the DS person does appear responsive to music, and rhythmic motor skills are useful in the pursuits of work and leisure activities. As DS people are now enjoying longer lives, as communities are now integrating them more successfully into everyday activities, and as mental health and education programs are becoming more involved in improving and encouraging their productive potential, it remains important to seek an increased understanding of their total needs and attributes. The intent of this study was to investigate one aspect of their motor skills, that of rhythmic synchronization, and to test it in a musical context.

Prominent DS traits include deficits in intellectual development, speech and language, reaction time, auditory discrimination, and structural size. In the area of assets, they show good general motor organization, relatively strong visual discrimination, the ability to imitate, and an agreeable disposition. In view of these factors it seems reasonable to assume that their performance in many areas may be enhanced by setting the conditions to favor their strengths and minimize their weaknesses.

The main questions under investigation in this research were concerned with the effect of tempo on performance accuracy in a motor synchronization task. Secondary questions were concerned with the study of the relationships of intelligence and age to performance accuracy.

A total of twenty-one DS subjects from the Greater Lansing community were randomly assigned to three experimental conditions, each characterized by a different stimulus tempo: 90 beats/minute, 150 beats/minute, or a tempo chosen by the subject. Each subject was asked to play a drum on the beat of rhythmic music after a short series of instructions and practice trials. Performance on the test item was recorded on a chart recorder. The subject's response beat lengths (RBL) were compared to the music stimulus beat lengths (SBL) and statistical analysis was performed on the differences of the group mean scores.

The differences were small, but found to be statistically significant at the .01 level. Subjects tended overall to play faster than the stimulus beat, with the least deviation error found in the group given the choice of tempo. The average of the tempi chosen by these seven subjects was 155 beats/minute, with a range from 114 to 228. The group playing at the tempo of 150 beats/minute had the next smallest mean deviation, and the 90 beats/minute group had the largest error. The largest error was a mean deviation of .055 second, representing only 8.7% of the stimulus beat length.

The evidence gathered in this study suggested that DS persons show a consistent, but somewhat inaccurate, motor response to rhythmic musical stimuli, with increased success at moderately fast tempi and highest success when playing at a tempo chosen by the individual. No significant relationship was evident between intelligence or age and rhythmic synchronization accuracy.

Conclusions

From the results of this study the conclusions listed below were reached in relation to the four research questions posed at the outset. The strength of these conclusions is influenced by the limitations imposed by the small sample size and the difficulties involved in testing the handicapped.

1. DS individuals show a consistent, but small degree of inaccuracy in motor synchronization. Deviations in beat length accuracy are less than .1 second per beat. In most everyday activities this synchronization error may be negligible. However, in music performance, in which very close rhythmic synchronization is necessary, and fine, immediate adjustments must be made from moment to moment, this amount of deviation would have a substantial effect on musical outcomes.
2. DS persons show a tendency to respond ahead of, or faster than, the beat of an external stimulus. Their individual responses show a consistency in deviation that appears to imply a degree of internal inflexibility with regard to the external tempo.
3. DS subjects reveal a propensity for, and the motor agility to respond to, very rapid tempi. At the faster tempi their performances show less deviation error in actual quantity of time than at the slower tempi. However, in proportion to the given stimulus beat length, error at the faster tempi is similar to that at the slower tempi. At the tempo of choice they show increased accuracy, regardless of tempo.

4. There seems to be no significant relationship between rhythmic synchronization ability and intelligence, as measured by IQ scores, or age.

Discussion

In contrast to the stereotype of the complacent, easy-going, often lethargic or stubborn DS individual with a slow reaction time, the subjects in this study presented somewhat surprising responses. Of particular interest is their attraction to and agility in playing the drum at rapid speeds. With the exception of two subjects who seemed a little shy, they all displayed eagerness, energy, and vigor in participating in this music study. Part of this type of response can be accounted for by the novelty of the situation, the attractiveness of playing on a drum to music, and the motivation inherent in one-to-one attention. Another factor that may have influenced especially those who chose their own tempo was the placement of the tapping speed test. Since it occurred between the exploratory playing of the drum and the first instructional example in which they chose a tempo to play, the last tempo lingering in their memories was most likely the rapid tapping test. However, those tested at 90 and 150 beats/minute also tended to gradually edge ahead of the beat in similar proportions to the beat length. One possible explanation could rest with the state of neurological arousal for motor performance that might be activated by the character of the sensory input, in this case the speed of the music. Thus the faster music might activate a proportionally greater motor response, while the tendency to exceed the beat remains intact.

The findings of Frith and Frith (1974) suggested that the DS person did not rely on learned motor programs to make adjustments in motor responses. In other words, when observing a predictable stimulus, they did not learn to anticipate the pattern of the movement. Instead, the DS person was thought to make corrections in movement based on immediate sensory feedback. With a stimulus as ongoing and temporarily fleeting as music, perception of error may seem so changeable that adjustment to it may not be possible in a person whose reaction time is deficient. Consequently, the motor response, once established, may proceed unchanged, without mediation from higher cognitive processes.

When the tempo is chosen by the DS person and the stimulus is matched to it, the success at synchronization may be aided by the seemingly automatic nature of the responses. In such cases, the person's motor responses may be already geared to the chosen tempo, and reliance on sensory input is not necessary. They may be making no conscious attempt to match the musical beat.

Inasmuch as the DS person's mental age falls in the two to four-year-old range and seldom exceeds seven years, it may be that the ability and even the concept of synchronizing with an external beat is not complete in its development. The low cognitive level may also have been a major detriment to understanding the instructions given by the experimenter. For example, the differentiation of "play as fast as you can" (in the tapping speed test) from "play as fast as you would like" (in choosing the tempo) may have been beyond the grasp of many of the subjects. By the same token, the beginning of the music may have been perceived simply as a cue to begin playing the drum and not necessarily to match the music's tempo by playing the drum. For these reasons, some of the subjects may have been playing independently of the tempo of the stimulus, raising a question as to whether motor synchronization was actually being tested at all in these subjects. The finding that these subjects performed better in the condition allowing choice of tempo could have some practical application in the pursuit of success at certain motor tasks. However, the strength of the tendency demonstrated here does not warrant the utilization of it to any great extent without more extensive research verification. This principle may be one addition to the strategies used in the clinical teaching of DS and other impaired persons.

Implications for Future Research

The results of this research study should be interpreted with some caution in light of the characteristics of the sample studied and the procedural issues that are discussed below. The sample size was small. The subjects covered a large age range (eight to forty-eight years), a fact of importance in view of the progressive cognitive deterioration of the DS person. Though the mean ages for the three groups were fairly close, the balance of males to females and the mean IQ scores were not. To effectively study the relationship of age and intelligence to other characteristics of DS, the sample studied should be larger and more representative of the levels chosen to study. When possible, ratings of functioning level or intelligence should be measured by the same or comparable testing instruments to help assure that reliable comparisons can be made of subjects. In studies of the effects of treatment interventions with DS, a more narrow age range would be recommended, with consideration given to their several cognitive growth stages.

A major source of difficulty in controlling intervening variables in this study was in providing the musical stimulus for the tempo of choice. It was the only condition in which an extra person was introduced into the testing setting. With some subjects this proved to be distracting. The use of a live performance, rather than recorded music as in the other conditions, also added an additional human variable to the stimulus. Some of the tempi chosen by the subjects were very fast, and consequently difficult for the pianist to maintain at a constant tempo. A solution to this problem in future research would be to use a recorded musical stimulus and a variable speed tape recorder.

Other recommendations for future research directions in the area of DS and rhythmic synchronization skills are as follows:

1. Investigate both fine motor rhythmic skills and gross motor skills involving movements using larger muscle groups, such as the legs
2. Study the relationships of rhythmic performance skills to intelligence, age, and sex
3. Study the relationship of motor synchronization skills to general motor skill development
4. Compare the effects of tempo choice on rhythmic synchronization on normal and other mentally retarded populations
5. Study longer test items of rhythmic synchronization response to identify patterns of adjustment to perceived synchronization error in DS individuals
6. Investigate the effects of training on the improvement of rhythmic synchronization skills

7. Study the effects of choice of tempo through a design in which each subject selects a preferred tempo during one session and is tested for synchronization accuracy at the chosen tempo during a later session

Studies that can increase the understanding and appreciation of the unique abilities and traits of people with Down's Syndrome will be valuable additions to medical and behavioral science, as well as to the efforts of programs and people who endeavor to successfully integrate and welcome these individuals into the community.

APPENDICES

APPENDIX A

GLOSSARY OF TERMS

GLOSSARY OF TERMS

Educable mentally retarded (educable mentally impaired): mentally handicapped individuals who have been determined to have IQ scores between 50 and 70, as measured by standardized intelligence tests

Intelligence: the mental capacity to apprehend facts and propositions and reason with them, measured as IQ by standardized tests such as Stanford-Binet, Wechsler Intelligence Scale for Children, Wechsler Adult Intelligence Scale, and Peabody Picture Vocabulary test

Motor response: a voluntary movement resulting from directed neuromuscular activity in reaction to a perceived stimulus or signal (in this study, to purposefully strike a drum with a mallet on the beat of the musical stimulus)

Musical stimulus: an auditory phenomenon of sound organized through the elements of melody, rhythm, harmony, timbre, and form (in this study, piano music played at a definite, specific tempo)

Response beat length: the period of time between the incidence of one response and the next (in this study, the amount of time between one instance of striking a drum with a mallet and the next, measured to .01 second)

Severely mentally retarded (severely mentally impaired): mentally handicapped individuals who have been determined to have IQ scores between 15 and 30, as measured by standardized intelligence tests

Stimulus beat length: the period of time between the incidence of one stimulus event and the next (in this study, the mean amount of time between one piano chord and the next in a series of chords, measured to .01 second and averaged to .001 second)

Synchronization: to act simultaneously with, or with the same period as, the occurrance of other events

Trainable mentally retarded (trainable mentally impaired): mentally handicapped individuals who have been determined to have IQ scores between 30 and 50, as measured by standardized intelligence tests

APPENDIX B

RAW DATA AND DEMOGRAPHIC INFORMATION

RAW DATA AND DEMOGRAPHIC INFORMATION

	Subject ID no.	Sex	Age in years	Age in months	IQ	Synchronization Score 1	Synchronization Score 2	SBL	Beats/ minute
Group A	1	M	12	148	37	.021	-.004	.635	94
	2	M	12	153	36	.085	-.078		
	3	F	13	160	35	.027	-.010		
	4	M	14	173	33	.061	-.061		
	5	M	17	213	64	.055	+.055		
	6	M	34	416	28	.080	-.080		
	*7	M	(47)	567	NA	(.307)	(-.307)		
	Means:		17.0		38.8	.055	-.030		
Group B	8	M	12	153	45	.046	-.051	.381	155
	9	F	14	168	43	.038	+.036		
	10	F	14	176	53	.036	+.032		
	11	M	17	214	54	.027	.000		
	12	M	18	223	36	.004	.000		
	13	F	26	318	51	.003	.000		
	14	M	48	586	NA	.053	-.056		
	Means:		21.9		47.0	.030	-.006		
Group C	15	F	8	101	45	.035	-.035	.263	228
	16	F	8	105	42	.001	.000	.448	134
	17	M	12	154	46	.009	-.009	.311	193
	18	F	17	207	44	.035	+.035	.425	141
	19	M	23	276	36	.003	.000	.342	175
	20	F	26	315	49	.005	.000	.400	150
	21	F	42	512	43	.000	.000	.528	114
	Means:		19.9		43.6	.013	-.001	.388	155

*Subject's data not included in statistical analysis

APPENDIX C

RHYTHMIC SYNCHRONIZATION TEST (Procedure)

RHYTHMIC SYNCHRONIZATION TEST (Procedure)

1. Preliminary Activities

   a) Introduction to subject

      "I'm glad you came to do some music activities with me today. I think you will enjoy what we do. I want to learn how people do certain musical things. You can help me by doing all the things that I ask you to do."

   b) Warm-up activity

      "First let's loosen up and warm up with some music. Please sit in that chair, and I will sit here. Follow me and do what I do."

      (Start tape. Do some claps, pats, stamps, stretches, and other rhythmic movements to recorded music.)

   c) Exploratory drum playing (last fourteen subjects only)

      "Now we're going to play on this drum. Let's practice hitting it first."

      (Take turns tapping drum with mallet. Practice together playing fast and slow.)

   d) Tapping Speed Test (last fourteen subjects only)

      "When I tell you to start, I would like you to play the drum as fast as you can. Start playing now. . . stop."

      (Cue assistant to start paper recorder. Cue subject to start playing. Count ten seconds. Cue subject to stop playing.)

2. Training segment

   a) "Next we are going to play the drum to music. This is how I would like you to play it. Please listen and watch."

      (Start music tape and play drum with mallet while S watches.)

b) "Now let's do it together. Listen and play with me to the music."

(Give S a mallet, and both play all the way through.)

c) "Let's do it again, and you keep playing, even when I stop. Play until the music stops."

(Both begin together. Fade response about half way through. Use verbal and gestural cues if necessary.)

d) "This time I'd like you to play it all by yourself. Keep playing until the music stops."

(S play alone to music. Cue only if necessary.)

3. Rhythmic Synchronization Test

"Thank you. I like hearing you play. I would like you to do it for me one more time. Listen for the music and play until it stops."

(Cue assistant to start paper recorder. Sit quietly. Give verbal encouragement to keep playing only if necessary.)

4. Final activity

"Thank you very much for doing this music with me. I've enjoyed it, and you have helped me. To end up maybe you would like to choose something to do. We could play the guitar, or another instrument, or sing a song, or maybe play something on the piano together. What would you like to do?"

(Participate with S in final activity)

(Procedure for Tempo of Choice)
steps 2 and 3 only

2. Training segment

a) "Next we are going to play the drum with the piano. Show me how fast you would like to play it. You can play as fast or as slow as you like, but stay at the same speed once you start. Start when you are ready."

(S plays drum at tempo of choice. Pianist assistant sets metronome at this tempo.)

"Good. Stop playing now and I will play with the piano the first time through. Please listen and watch."

(Let 8 clicks pass, count "1, 2, 3, 4, 1, 2, ready, go", and play drum with piano music.)

b) "Now let's do it together. Show me again how fast you like to play. Start when you are ready."

(S plays drum. Pianist sets metronome at S's tempo.)

"Good. Stop playing now, and we will both start together with the piano."

"Let metronome click 8 times, give verbal counting cues, and both play all the way through with piano music.)

c) "Let's do it again. Start when you are ready."

(S plays drum. Pianist sets metronome.)

"Good. Stop playing now, and we will both start together. You keep playing, even when I stop. Play until the <u>piano</u> stops."

(Same as #2. Fade response about half way through. Use verbal and gestural cues if necessary to prompt S to continue playing.)

(Procedure for Tempo of Choice)

d) "This time I'd like you to play it all by yourself. Start when you are ready."

(S plays drum. Pianist sets metronome.)

"Good. Stop now, and I will start you and the piano together. Keep playing until the piano stops."

(Let metronome click 8 times, give verbal counting cues. S plays alone to piano music. Cue only if necessary.)

3. Test of rhythmic synchronization

a) "Thank you. I like hearing you play. I would like you to do it for me one more time. Start when you are ready."

(S plays drum. Pianist sets metronome.)

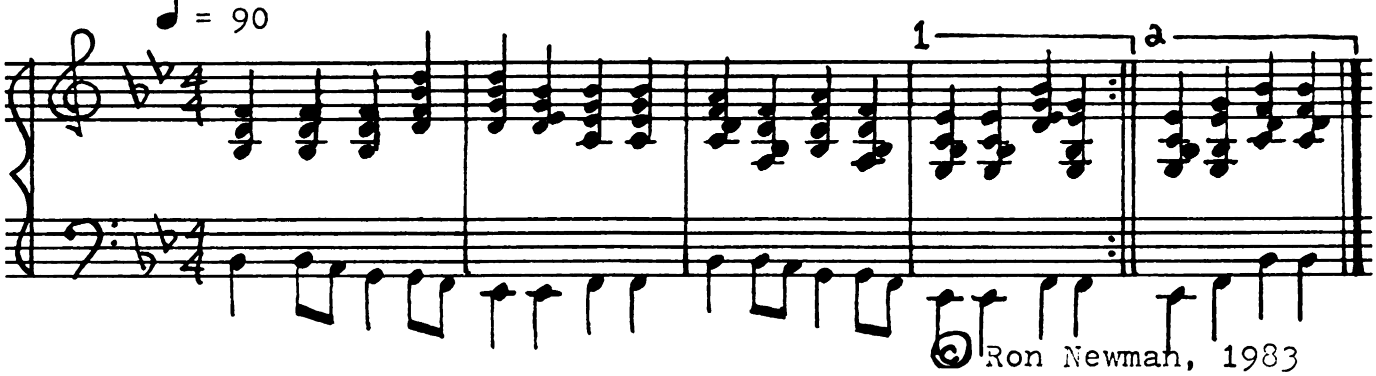
b) "OK, stop playing, and I'll count for you and the piano. Please play until the piano stops."

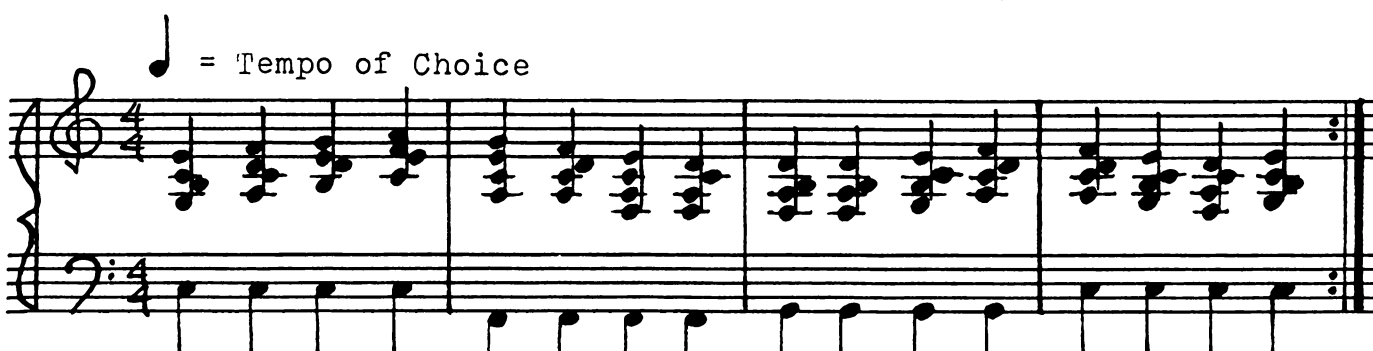
(Start paper recorder. Give counting cues. Give only verbal encouragement to keep playing if necessary.)

APPENDIX D

MUSIC USED IN TESTING

MUSIC USED IN TESTING





FOOTNOTES

FOOTNOTES

1. Arthur T. Jersild and Sylvia F. Bienstock, Development of Rhythm in Young Children, Child Development Monographs, No. 22 (New York: Columbia University, 1935), p. 69.

2. Rupert Thackray, "Rhythmic Abilities and Their Measurement," Journal of Research in Music Education 17:1 (1969), p. 146.

3. J. Perney, "Musical Tasks Related to the Development of the Conservation of Metric Time," Journal of Research in Music Education 24:4 (1976), p. 160.

4. Marily R. Pflederer, "The Responses of Children to Musical Tasks Embodying Piaget's Principle of Conservation," Journal of Research in Music Education 12:4 (1964), p. 266.

5. M. P. Zimmerman and Lee Sechrest, "Brief Focused Instruction and Musical Concepts," Journal of Research in Music Education 18:1 (1970), p. 34.

6. David Gibson, Down's Syndrome (Cambridge, England: Cambridge University Press, 1978), p. 229.

7. Thackray, op. cit. p. 146.

8. Ruth Phyllis Kaplan, "A Criterion-referenced Comparison of Rhythmic Responsiveness in Normal and Educable Mentally Retarded Children (Mental Ages 6-8)" (Unpublished Ph.D. dissertation, University of Michigan, 1977), pp. 57-62.

9. Ibid., pp. 22-49.

10. Alan H. Drake, "An Experimental Study of Selected Variables in the Performance of Musical Durational Notation," Journal of Research in Music Education 16:4 (1968), p. 337.

11. Dorothea M. Ross, Sheila A. Ross, and Shari L. Kuchenbecker, "Rhythm Training for Educable Mentally Retarded Children," Mental Retardation 11 (December, 1973), p. 22.

12. Gibson, op. cit., p. 249.

13. Ibid., p. 32.

14. Ibid., p. 49.

15. Ibid., p. 41.

16. C. E. Benda, _Down's Syndrome_ (New York: Grune and Stratton, 1969), p. 40.

17. G. F. Smith and J. M. Berg, _Down's Anomaly (Edinburgh, Scotland: Churchill Livingstone, 1976)_, pp. 239-243.

18. Gibson, _op_. _cit_., p. 139.

19. Ibid., p. 148.

20. Ibid., p. 243.

21. Uta Frith and Christopher D. Frith, "Specific Motor Disabilities in Down's Syndrome," _Journal of Child Psychology Psychiatry_ 15 (1974), p. 299.

REFERENCES

REFERENCES

Andrews, Frances M. and Deihl, Ned C. "Development of a Technique for Identifying Elementary School Children's Musical Concepts." Journal of Research in Music Education, 18:3 (Fall, 1970), 214-222.

Bagenstos, Naida T. and LeBlanc, Albert. "The Role of Research in the Aesthetic Education Program." Council for Research in Music Education Bulletin, 43 (Summer, 1975), 65-85.

Benda, C. E. Down's Syndrome. New York: Grune and Stratton, 1969.

Bentley, Arnold. Musical Ability in Children and Its Measurement. London: George G. Harrap and Co. Ltd., 1966.

Bilovsky, D. and Share, J. "The ITPA and Down's Syndrome: An Exploratory Study." American Journal of Mental Deficiency, 70 (1965), 78-82.

Bixler, John. "Musical Aptitude in the Educable Mentally Retarded Child." Journal of Music Therapy, 5:2 (June, 1968), 41-43.

Brushfield, T. "Mongolism." British Journal of Children's Diseases, 14, (1924), 240-258.

Cantor, Gordon N. and Girardeau, Frederic L. "Rhythmic Discrimination Ability in Mongoloid and Normal Children." American Journal of Mental Deficiency, 63, (1959), 621-625.

Carr, Janet. "Mental and Motor Development in Young Mongol Children." Journal of Mental Deficiency Research, 14, (1970), 205-220.

Christianson, Helen. Bodily Rhythmic Movements of Young Children in Relation to Rhythm in Music, No. 736: Contributions to Education. New York: Bureau of Publications, Teachers College, Columbia University, 1938.

Clarke, A. D. B.; Hermelin; and Fliess. "Adult Imbeciles, Their Abilities and Trainability." Lancet, 2 (1955), 337-339.

Cornwell, A. C. and Birch, H. G. "Psychological and Social Development in Home-reared Children with Down's Syndrome (Mongolism)," American Journal of Mental Deficiency, 74 (1969), 341-350.

Cox, Sister M. Olivia, F.S.P.A. "A Descriptive Analysis of the Response to Beat, Meter, and Rhythm Pattern by Children, Grades 1 to 6." Unpublished Ph.D. dissertation, University of Wisconsin-Madison, 1977.

Davis, Walter E. and Kelso, J. A. Scott. "Analysis of 'Invariant Characteristics' in the Motor Control of Down's Syndrome and Normal Subjects." Journal of Motor Behavior, 14:3 (1982), 194-211.

Dorhout, Albert J. "An Investigation into the Nature of Tempo Perception." Unpublished Ph.D. dissertation, Northwestern University, 1979.

Drake, Alan H. "An Experimental Study of Selected Variables in the Performance of Musical Durational Notation." Journal of Research in Music Education, 16:4 (Winter 1968), 329-338.

Dummer, Gail Marie. "Information Processing in the Acquisition of Motor Skills by Mentally Retarded Children." Unpublished Ph.D. dissertation, University of California-Berkeley, 1978.

Fitzpatrick, F. K. "The Use of Rhythm in Training Severely Subnormal Patients." American Journal of Mental Deficiency. 63:6 (1959), 981-987.

Frith, Uta and Frith, Christopher D. "Specific Motor Disabilities in Down's Syndrome." Journal of Child Psychology Psychiatry, 15 (1974), 293-301.

Gibson, David. Down's Syndrome. Cambridge, England: Cambridge University Press, 1978.

Gilbert, Janet Perkins. "The Development of Motoric Music Skills in Children Ages Three Through Six." Unpublished Ph.D. dissertation, University of Kansas, 1979.

Groves, William C. "Rhythmic Training and Its Relationship to the Synchronization of Motor-Rhythmic Responses." Journal of Research in Music Education, 17:4 (Winter, 1969), 408-415.

Heinlein, C. P. "A New Method of Studying the Rhythmic Responses of Children, Together with an Evaluation of the Method of Simple Observation." Pedagogical Seminary and Journal of Genetic Psychology, 36 (June, 1929), 205-227.

Hermelin, Beate and O'Connor, N. "Shape Perception and Reproduction in Normal Children and Mongol and Non-Mongol Imbeciles." Journal of Mental Deficiency Research, 5 (1961), 67-71.

Hufstader, Ronald A. "An Investigation of a Learning Sequence of Music Listening Skills." Journal of Research in Music Education, 25:3 (1977). 184-196.

Jersild, Arthur T. and Bienstock, Sylvia F. Development of Rhythm in Young Children, Child Development Monographs, No. 22. New York: Columbia University, 1935.

Jones, Russell L. "The Development of the Child's Conception of Meter in Music." Journal of Research in Music Education, 24:3 (1976), 142-154.

Kaplan, Phyllis Ruth. "A Criterion-referenced Comparison of Rhythmic Responsiveness in Normal and Educable Mentally Retarded Children (Mental Ages 6-8)." Unpublished Ph.D. dissertation, University of Michigan, 1977.

Kuhn, Terry Lee. "Discrimination of Modulated Beat Tempo by Professional Musicians." Journal of Research in Music Education, 22:4 (1974), 270-277.

Kuhn, T. L. and Gates, E. E. "Effect of Notational Values, Age and Example Length on Tempo Performance Accuracy." Journal of Research in Music Education, 23:3 (1975), 203-210.

Langille, Connie M. "An Investigation of the Relationship of Aural Rhythm Pattern Perception to Reading Skills of Second Grade Students." Unpublished Ph.D. dissertation, University of Michigan, 1977.

Lienhard, Marta E. "Factors Relevant to the Rhythmic Perception of A Group of Mentally Retarded Children." Journal of Music Therapy, 13:2 (Summer, 1976), 58-65.

Lyle, J. G. "A Study of the Verbal Ability of Imbeciles in Day Schools and in an Institution." (unpublished thesis). Cited by Janet Carr, "Mental and Motor Development in Young Mongol Children." Journal of Mental Deficiency Research, 14 (1970), 219.

Marcinak, Francis M. "Investigation of Relationship Between Music Perception and Music Performance." Journal of Research in Music Education, 22:1 (Spring, 1974), 35-44.

McDowell, Robert H. "The Development and Implementation of a Rhythmic Ability Test Designed for Four-year-old Preschool Children." Unpublished Ed.D. dissertation, University of North Carolina - Greensboro, 1974.

McLeish, J. and Higgs, G. An Inquiry into the Musical Capacities of Educationally Sub-Normal Children. Occasional Research Papers No. 1. Cambridge, England: Cambridge Institute of Education, n.d.

Moore, B. C.; Thuline, H. C.; and Capes, L. "Mongoloid and Non-mongoloid Retardates: A Behavioral Comparison." American Journal of Mental Deficiency, 73 (1968), 433-436.

O'Connor, N. and Hermelin, Beate. "Visual and Stereognostic Shape Recognition in Normal Children and Mongol and Non-mongol Imbeciles." Journal of Mental Deficiency Research 5, (1961), 63-66.

Perney, J. "Musical Tasks Related to the Development of the Conservation of Metric Time." Journal of Research in Music Education, 24:4 (Winter, 1976), 159-168.

Peters, Martha L. "A Comparison of the Musical Sensitivity of Mongoloid and Normal Children." Journal of Music Therapy, 7:4 (Winter, 1970), 113-123.

Petzold, R. G. "The Development of Auditory Perception of Musical Sounds by Children in the First Six Grades." Journal of Research in Music Education, 11:1 (1963), 21-43.

__________. "Auditory Perception by Children." Journal of Research in Music Education, 17:1 (1959), 82-87

Pflederer, Marilyn R. "The Responses of Children to Musical Tasks Embodying Piaget's Principle of Conservation." Journal of Research in Music Education, 17:1 (1964), 251-268.

Quaytman, W. "The Psychological Capacities of Mongoloid Children in a Community Clinic." Quarterly Review of Pediatrics, 8 (1953), 255-267.

Rainbow, Edward. "A Longitudinal Investigation of the Rhythmic Abilities of Pre-school Aged Children." Council on Research in Music Education Bulletin, 50 (Spring, 1977), 55-61.

Ross, Dorothea M.; Ross, Sheila A.; and Kuchenbecker, Shari L. "Rhythm Training for Educable Mentally Retarded Children." Mental Retardation, 11 (December, 1973), 20-23.

Rowlson, John S. Senior Mental Retardation Therapist, Bretten Square Industries, Holt, Michigan (Work activities program in Programs for the Mentally Retarded under the auspices of the Clinton, Eaton, Ingham Counties Community Health Board). Interview, 30 June 1983.

Sievers, Clement H. "A Study of Rhythmic Performance with Special Consideration of the Factors Involved in the Formation of a Scale for Measuring Rhythmic Ability." The Measurement of Musical Development. Edited by George D. Stoddard. University of Iowa Studies in Child Welfare, Vol. VII, No. 1. Iowa City: University of Iowa, 1932.

Shuttleworth, G. E. Mentally Deficient Children. (2nd Ed.) London: H. K. Lewis, 1900.

Smith, G. F. and Berg, J. M. Down's Anomaly. Edinburgh, Scotland: Churchill Livingstone, 1976.

Smoll, F. L. "Preferred Tempo in Performance of Repetitive Movements." Perceptual and Motor Skills, 40 (1975), 439-442.

Smoll, F. L. and Schutz, R. W. "Relationships Among Measures of Preferred Tempo and Motor Rhythm." Perceptual and Motor Skills, 46 (1978), 883-894.

Taebel, Donald K. "The Effect of Various Instructional Modes on Children's Performance of Music Concept Tasks." Journal of Research in Music Education, 22:3 (Fall, 1974), 170-183.

Thackray, Rupert. "Rhythmic Abilities and Their Measurement." Journal of Research in Music Education, 17:1 (1969), 144-148.

Tredgold, R. F. and Soddy, K. A Textbook of Mental Deficiency. Baltimore: Williams and Wilkins, 1956.

Vance, Thomas F. and Grandprey, Medora B. "Objective Methods of Ranking Nursery School Children on Certain Aspects of Musical Capacity." Journal of Educational Psychology, 22 (1931), 577-584.

Wallin, J. E. W. Children with Mental and Physical Handicaps. New York: Prentice-Hall, 1949.

Walton, D. and Begg, T. L. "Adult Imbeciles." Lancet, 2 (1955), 616-617.

Williams, Harold M. "Studies in the Rhythmic Performance of Pre-school Children." The Measurement of Musical Development. Edited by George D. Stoddard. University of Iowa Studies in Child Welfare, Vol. VII, No. 1. Iowa City: University of Iowa, 1932.

Wolff, Karen Lias. "The Effects of General Music Education on the Academic Achievement, Perceptual-Motor Development, Creative Thinking, and School Attendance of First-grade Children." Unpublished Ph.D. dissertation, University of Michigan, 1979.

Zimmerman, M. P. and Sechrest, Lee. "Brief Focused Instruction and Musical Concepts." Journal of Research in Music Education, 18:1 (1970), 25-36.