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THE USE OF MELODIC-RHYTHMIC MNEMONICS WITH  
LEARNING DISABLED AND NORMAL STUDENTS  
AS AN AID TO RETENTION

By

Kay E. Gfeller

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## ABSTRACT

### THE USE OF MELODIC-RHYTHMIC MNEMONICS WITH LEARNING DISABLED AND NORMAL STUDENTS AS AN AID TO RETENTION

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This study examined the effectiveness of one particular strategy, the melodic-rhythmic mnemonic, as an aid to retention of academic facts--specifically, multiplication facts. According to some researchers in learning disabilities, using such strategies helps learning disabled students, who may exhibit poor short-term memory, in keeping pace with successful learners who spontaneously initiate strategies.

Subjects included 30 learning disabled and 30 normal male students, ages 9.0 to 11.9 years with 90 to 120 I.Q.s, as measured by a Slosson Intelligence Test. All subjects participated in two experiments conducted over three days.

Experiment I consisted of a pretest, a single rehearsal of multiplication facts, and, immediately following rehearsal, a posttest for short-term memory. This test examined the influence of the independent variables, group membership (learning disabled or normal), and rehearsal mode (musical or verbal) on the dependent variable, short-term memory.

Immediately following Experiment I, all subjects participated in Experiment II: four additional rehearsals spaced over three days. Treatment consisted of further exposure to multiplication facts in order to examine the effect of group membership, rehearsal mode, and extended time. The independent variable of teaching method was added: (a) repetition only, and (b) repetition with modeling and cuing.

### The Results

Data from Experiment I were analyzed through univariate analysis of covariance. Main effects of group membership and rehearsal mode were statistically significant at the .05 level, indicating that normals showed greater recall than learning disabled subjects, and that greater recall for both groups resulted from verbal as opposed to musical rehearsal. There was no significant interaction effect of group by rehearsal mode.

Data from Experiment II were analyzed using multivariate analysis of covariance for repeated measures. Interaction of rehearsal mode by teaching method was statistically significant at the .0001 level. This supported musical rehearsal in conjunction with modeling and cuing as an effective aid to retention for both groups.

Further hypotheses for (a) main effect of group, (b) interaction effects of group by rehearsal mode, and (c) group by rehearsal mode by teaching method were statistically nonsignificant at the .05 level.



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## CHAPTER I

### OVERVIEW OF THE PROBLEM

#### Purpose

The purpose of this study was to examine melodic-rhythmic mnemonic devices as an aid to retention for learning disabled\* and normal children. The effectiveness of this mnemonic, which will be called musical rehearsal, was measured in a two-part experiment examining the following variables: (a) subject classification (learning disabled versus normal students), (b) mode of rehearsal (musical versus normal speech rehearsal), and (c) method of teaching (repetition versus repetition with modeling and cues). While many studies for short-term memory use mnemonic devices in conjunction with serial lists, this study investigated the effectiveness of such a device with actual academic information which necessitated a closed-ended response -- in this case, multiplication facts.

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\*According to law R.340.1713 of the State of Michigan's law for special education, specific learning disability means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, spell, or to do mathematical calculations. The term includes conditions such as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental learning problems which are primarily the result of visual, hearing, or motor handicaps, of mental retardation, or emotional disturbance, or of environmental, cultural, or economic disadvantage.

### Background of the Problem

Finding effective and efficient teaching methods for learning disabled children is an ongoing concern of parents, educators, and school administrators. Teachers and parents most directly involved with the students are acutely aware of the career limitations and social handicaps that a student with academic problems faces. State legislators and administrators are confronted continually with budgetary concerns that arise from the high cost of special education programming. For these reasons, finding effective and efficient teaching strategies present a significant problem in special education.

While public sensitivity to the educational needs of the learning disabled has grown rapidly within the past two decades, ophthalmologists and neurologists have been aware of specific reading problems as early as 1917. Hinshelwood (1917) and Orton (1928) both viewed "word blindness" as a neurological condition which affected the individual's ability to read despite normal visual acuity and normal intelligence.

In 1947, Strauss and Lehtinen's description of the brain injured child resulted in an entirely new category of exceptional children. This category included a collection of children with disturbances in perception, thinking, and emotional behavior caused by some type of organic impairment which impeded normal learning processes, despite normal acuity and I.Q. Since 1947, causal labels (brain injury, minimal brain dysfunction) have been discarded in favor of descriptive labels (attention deficit disorders, learning disabilities) which more directly describe the resulting behaviors and problems. This disability has been approached as a perceptual-motor problem



(Cruickshank and Kephart) and as a cognitive or language problem (Johnson and Myklebust); but, despite the varying approaches, these professionals have worked toward the common goal of increased academic success for the learning disabled student.

Like other special education personnel, music educators and music therapists are seeking more effective remediation strategies for the learning disabled. These professionals use music as a medium for reinforcing appropriate behavior, academic concepts, and motor development. Past research by music therapists has documented the use of music as an effective motivational tool for reinforcing various behavioral and academic goals; however, the bulk of this research has been with either mentally retarded or normal individuals. Research with retardates forms the basis for many of the current musical interventions used with the learning disabled. Yet the learning disabled constitute a population with characteristics and needs unique from either mentally retarded or normal children.

In the search for effective musical strategies for the learning disabled, there are two problems that arise: (a) there exists very limited methodological literature on using music with learning disabled students, and even less research on the effectiveness of musical methods with this population; and (b) much of the extant programming literature is developed either from research on the mentally retarded or from perceptual or motor remediation theories such as those of Kephart, Getman, Cratty, and Doman and of Delcato (Phipps, 1975; Flick, 1975). While it appears that many learning disabled children do have some perceptual or motor problems, research findings are inconclusive at best, regarding the effectiveness of

isolating and remediating perceptual or motor skills. Furthermore, research data showing that academic improvement results from training is lacking (Lerner, 1976; Reid and Hresko, 1981; Hammill and Larsen, 1974).

If the validity of isolating and remediating perceptual-motor processes is questionable, and if the goal is to enhance academic learning, the use of music therapy interventions based on those theories should be closely reexamined for actual effect on academic proficiency. Additionally, music therapists have a professional responsibility to reevaluate the role of music interventions now used in view of current thinking and to maintain valid methodology.

One of the current trends in research and programming for the learning disabled is the cognitive approach, which includes development of teaching strategies for various academic tasks (Reid and Hresko, 1981). Cognition is a complex, process of knowing and perceiving, consisting of various thinking skills including memory. Memory capacity and recall facilitation has been a current focus of numerous investigations with the learning disabled:

It is widely recognized that the learning disabled have deficits\* in memory. Two of the six major areas of disability described by Myers and Hammill (1976) and all of the basic learning abilities described Valett (1969) involve memory. Many other writers (Chalfant and Scheffelin, 1969; Doering, 1968; Johnson and Myklebust, 1967; Kirt, 1966) have also reported that the learning disabled may experience difficulties with one or another memory tasks.<sup>1</sup>

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\*Disorder may be a more appropriate term, since deficit implies the lack of memory, as opposed to ineffective use of memory.

Reid and Hresko (1981) report that problems may occur in visual or auditory memory, ability to transfer information from short-term to long-term store, and in organization of incoming information. They stress that memory as an end in itself is not an appropriate educational goal. However, memory as it interacts with mastery of educational content is an important process which affects academic success. Thus, while memory exercises in and of themselves are of doubtful value, memory strategies (based on theories of the memory process) incorporated into presentation or rehearsal of classroom information may enhance academic performance. Some of the strategies which may enhance storage of information developed from our current understanding of the memory process include (a) organization or chunking of incoming stimuli; (b) effective rehearsal methods, including verbal rehearsal and mnemonic strategies; and (c) appropriate presentation and review rates (Reid and Hresko, 1981; Lerner, 1976).

Considering these suggestions, in what way can music act as an effective intervention in aiding retention of academic information? For years music therapists, working with the mentally retarded, have used songs to aid retention of selected concepts or knowledge of colors or numbers. While it is true that the mentally retarded have many characteristics which are different from the learning disabled, such as subnormal I.Q., many retardates also have memory problems (Kirk and Gallagher, 1979), though not necessarily with the same etiological base as learning disabled children. While the research results on music to aid retention have been inconclusive, several studies do support its use. For example, research by Isern (1958) and

Lathom (1970) support the use of music as an effective educational aid with the retarded.

Some researchers consider music to be an effective educational mediation because it functions as a motivator or because it is a novel and, thus, interesting stimulus; other researchers, however, see music's potential embodied in the organizational elements of rhythm and tonality, which may, in and of themselves, enhance meaningful communication and increased retention (Lathom, 1971; Seashore, 1919; Restle, 1970; Robinson and Solomon, 1974; and Bloomsitter and Creel, 1977).

Various psychoacoustical studies have shown that rhythmic organization and tonally based melodies do, indeed, aid meaning and retention of music without words. In addition, such musical structures superimposed upon verbal information have shown effective increase of recall in a short-term memory task using serial lists, such as unrelated digits (Jellison, 1976; Prickett, 1974).

Although the organizational components of music have proven effective in aiding retention of serial lists, do these same components facilitate recall when utilized in an actual academic task? Researchers in the memory field believe that memory processes can differ depending on the nature of information to be recalled (Norman, 1976). It is, therefore, important when developing memory strategies based on findings from research with serial tasks to reexamine the effectiveness of those strategies when used in conjunction with meaningful academic information.

Further, in view of the heterogeneous nature of the learning disabled population,\* it is important to examine critically a strategy considering individual student needs as opposed to viewing a strategy as an all-effective panacea. Unfortunately, researchers too often face one of the following research problems: (a) there is little control over heterogeneity of wide ranging characteristics in the learning disabled population; (b) the research has included so little descriptive information on the subject sample that replication of the study is thwarted and generalizability of findings is clouded; or (c) the strategy under examination has been analyzed only in conjunction with group trends, with little attention to specific subject characteristics within the group. In view of these research problems, Keogh et al. (1981) emphasize the importance of detailed subject description along with research findings or methodological recommendations.

In summary, while music therapists have recommended the use of music as an educational aid for the learning disabled (Phipps, 1975; Flick, 1975; Roskam, 1977), its value must be examined systematically in view of current research findings in the field of learning disabilities. Additionally, musical methods must be examined for actual benefit to academic growth, always keeping in mind the importance of individual educational needs within the learning disabled population.

---

\*This population represents a conglomeration of learning problems despite normal I.Q. and sensory acuity.

### The Problem

This study investigated whether melodic-rhythmic organization acted as an effective mnemonic device to aid learning disabled and normal students in retention during a short term memory task. The problem was broken into the following subproblems:

1. Can the use of melodic-rhythmic structure facilitate encoding and retention\* in a short term memory task?
2. Can selected melodic-rhythmic patterns introduced during the rehearsal process provide an effective retrieval cue during recall?
3. Is the effectiveness of a melodic-rhythmic mnemonic strategy increased by modeling its use and providing retrieval cues? (See the definitions for these terms at the close of this chapter.)
4. Do learning disabled and normal students exhibit greater or lesser retention in interaction with specific methods of verbal or musical rehearsal?
5. When provided with memory strategies and their appropriate use over time, will learning disabled students exhibit similar growth in retention as normal students?
6. Within the heterogeneous learning disabled population, do any particular subgroups (categorized by severity

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\*Darley, Glucksberg, Kamin, and Kinchla (1981) describe encoding as the way information is first stored in the memory process, retention describes the preservation of information over time, and retrieval is the manner in which information is recovered from memory.

of academic or attentional problems, activity level, or area of academic disability) respond differently to various treatment methods?

These subproblems were examined through two experimental procedures, Experiment I and Experiment II. Experiment I consisted of a pretest, a single rehearsal of the memory task, followed immediately by a posttest to assess recall. Testing examined the effects of two independent variables, group level (normal or learning disabled), and rehearsal mode level (musical or verbal rehearsal) on the dependent variable, posttest recall of the memory task.

The following hypotheses were generated about the expected findings in Experiment I:

1. Normal students will show significantly greater improvement in recall accuracy than learning disabled subjects in both musical and verbal rehearsal.
2. All subjects will show significantly greater improvement in recall accuracy from musical as opposed to verbal rehearsal.
3. A significant interaction effect will result from group level (normal or learning disabled) by rehearsal mode level (musical or verbal).

Experiment II, which consists of three repeated measures of the dependent variable recall accuracy, examined the effect over time of the following independent variables: group level (normal and learning disabled); rehearsal mode level (musical and verbal rehearsal); and teaching method (a) posttest only for control purposes, (b) method I

which is simple repetition of the memory task, and (c) method II which included modeling and cuing along with the memory task.

The following hypotheses are related to research procedures in Experiment II:

1. Normal students will show significantly greater improvement in recall accuracy than learning disabled students in all treatment methods.
2. All subjects will show greater improvement in recall accuracy following musical rehearsal compared to verbal rehearsal.
3. All subjects will show significantly greater improvement in recall accuracy between levels of teaching methods (posttesting only versus methods I and II combined and method I versus method II).
4. A significant interaction effect will result from the following combinations across time:
  - a. group level by rehearsal mode level,
  - b. group level by teaching method level,
  - c. rehearsal mode level by teaching method alone,  
and
  - d. group level by rehearsal mode level by teaching method level.

#### Importance of the Study

The field of music therapy, that is, using music to achieve specific therapeutic goals, is a relatively young discipline in which continued and more thorough research efforts are needed greatly.



Music therapists are becoming increasingly aware of the need to research and document actual effectiveness of utilized music therapy methodology.

As music therapists expand their practice to include work with the learning disabled, increased research efforts become even more vital to success and credibility. Currently, there is much methodological reliance on research resulting from work with the mentally retarded, and very little available research exists on the use of music as an educational aid for the learning disabled. In addition, several issues in the field of learning disabilities require further study. First, there is a critical need for more effective teaching techniques. With a shift away from isolated remediation of perceptual motor skills and a movement toward improved cognitive performance (Reid and Hresko, 1981), existing teaching techniques must be examined for effectiveness, and further approaches developed.

Lerner (1976) and Reid and Hresko (1981) have identified memory problems as one area of cognitive functioning that requires further understanding and investigation. One example of a specific academic task in which memory problems surface is illustrated by Moyer and Moyer (1978). They discuss a problem that may occur in a mainstreamed situation in which a class is expected to learn multiplication tables:

Difficulty recalling the basic facts is not limited to learning disabled children: memorizing the facts is a laborious process for many children. However, for those children with accompanying memory problems, this task may be overwhelming.<sup>2</sup>

It is worth noting that during the data collection process of this study, it was not at all unusual to find 10 and 11 year old learning disabled students still struggling with memorization of the same facts

that the majority of their normal counterparts had mastered at age nine.

Second, currently available or newly developed teaching strategies must be scrutinized for actual effectiveness. Rather than assuming a method to be effective, it should be examined with students in an actual academic task. For example, Reid and Hresko (1981) have recommended the use of rhythmic grouping as a tool for aiding memory: "Notice, for example, how often television commercials and pop songs take advantage of rhymes and rhythms . . . . Children are . . . responsive to these techniques."<sup>3</sup> While this recommendation is found in a general text on learning disabilities, this particular strategy suggestion is not supported by specific research findings.

Another example of currently utilized musical memory aids are existing educational tapes and records which present multiplication facts with a musical format. Several teachers contacted during the study stated that they use music-related methods; but when asked whether these methods actually aided retention, they were uncertain. It is possible as well that a method which might be motivating and thus effective for a normally achieving students, might actually be over-stimulating or distracting for the learning disabled student.

When examining the effectiveness of a teaching strategy, the heterogeneous make up of the learning disabled population creates additional research questions. Frequently, researchers fail to report specific details of subject selection, forcing the reader to speculate about the characteristics of the test sample (Keogh et al., "Summary Report--UCLA Marker Variable Project," 1981, unpublished). As a result of vague reporting, several problems hamper interpretation of

research results: (a) the reader has little or no information concerning the effectiveness of a teaching strategy as it interacts with specific subject characteristics, (b) the generalizability of the study becomes clouded, and (c) replication of the study becomes next to impossible. In short, research studies must provide adequate documentation of subject characteristics as they interact with specific teaching strategies.

To conclude, in order to provide viable programming for the learning disabled, music therapists should critically examine the effectiveness of methodology in view of specific learning needs and subject characteristics. The truly professional music therapist cannot assume interventions to be effective. In addition, because memory is a cognitive skill which affects so many areas of learning (Donahoe and Wessells, 1980), the development of effective remediation techniques which will enhance retention deserves more thorough consideration.

#### Assumptions

For the purpose of this study, the following assumptions were made:

1. Those individuals who have been identified as learning disabled by an individual educational program report, prepared in accordance with state and federal regulations, are actually of that disability. In addition, information on diagnosis and severity of impairment, as provided by special education personnel, is assumed accurate. I.Q. measurement, as measured by the Slosson Intelligence Test, is considered an

adequate screening device to help assure presence of normal intelligence level among selected subjects, a key criterion.

2. Individuals randomly drawn from regular classrooms with no official record of learning disabilities or handicapping conditions constitute normal subjects. Precautions taken to increase this probability include the exclusion of any students with academic problems which might reflect undiagnosed learning disabilities or borderline retardation as reported by classroom teachers. In addition, none of the students had been referred for special education or had been retained due to academic difficulties.
3. Those learning disabled and normal subjects selected are a representative sample of the 9.0 to 11.9 year old male population for the greater Grand Rapids, Michigan, area with comparable reported characteristics.
4. The wide range of learning and behavioral characteristics associated with the broad term learning disabilities is accounted for through randomized assignment of subjects to specific treatment and control group.
5. The memory task used in this study constitutes a short-term memory task due to the brief intervening time between rehearsal and posttesting and due to the transient active state of the rehearsal and posttest

process. The format of the questions most closely resembles the paired-associates type of memory task since it requires an association of the item stem (ex., 8x9) with the accurate matching response (ex., =72).

It should be noted that because rehearsals are repeated over five sessions, the type of memory process involved probably shifts between strict short-term memory and the indefinite transitional stage which links information to long-term store. Currently, researchers are unable to conclude with any certainty the exact point at which information enters long-term store. This hotly debated question requires further investigation; but for the purposes of this study, the following explanation by Anderson (1980) will be utilized to clarify the contrast of the two phases:

The term short-term memory as it contrasts with long-term memory can be confusing. The phrase short-term indicates that some of the information in the active state may be lost when it becomes inactive. Thus, information in short-term memory may not become a permanent part of long-term memory. However, short-term memory can contain information from long-term memory . . . (while drawing on a permanent fact in long-term memory) the fact is active in short-term memory and long-term memory are not opposites; rather, they overlap. Short-term memory refers to a small amount of information that is in a transient, active state. Long-term memory refers to a large body of information that is relatively permanently encoded. In other words the two terms can refer to different aspects of the same information.<sup>4</sup>

Based on this discussion and for purposes of clarification in this study, the memory task within the experimental procedure will be referred to as short-term memory.

6. The melodic-rhythmic patterns used in this study constitute musical rehearsal, and the normal speech patterns (reviewed by two speech pathologists for

normalcy) constitute what will from this point be called verbal rehearsal.

#### Limitations

1. Results of this study cannot be generalized beyond the following group characteristics: male, ages 9.0 to 11.9, 90-120 I.Q., and residents of the greater Grand Rapids, Michigan, area.
2. This study does not intend to examine causal factors or specific etiological groupings such as language problems, motor deficits, dyslexia, or minimal brain dysfunction found in the learning disabled population.
3. While attention and motivation are important factors in accurate and efficient recall, these factors are not examined directly.
4. This study does not examine mathematical competency or remediation of a conceptual or procedural nature. It is limited to rehearsal methods of a closed-ended memory task--specifically, multiplication facts of the numbers 7 and 8 (single digit multiplication). While mnemonic devices may be used with materials in other academic subjects, this study is limited to retention of multiplication facts.

#### Theoretical Background

In the investigation of music as an aid to retention, supporting theoretical premises encompass not only the structure and processing of musical stimuli, but also the memory process itself. In addition,

in an investigation of learning disabled subjects, an extra dimension is added to the memory process since these subjects often experience memory problems and require special interventions to ameliorate poor retention.

In developing an appropriate teaching strategy to aid retention of the learning disabled, one must consider the following: (a) In the normal memory process, what types of mental activity or manipulation of stimuli enhance retention? (b) What are probable sources of memory breakdown among the learning disabled, and how can classroom information be presented or rehearsed in order to facilitate a more effective memory process? and (c) What components of music might aid efficient encoding or retrieval in the memory process?

First, consider the normal memory process and methods which facilitate retention. The storage of information is believed to take place in three stages: sensory store, short-term store, and long-term store. In order for information to enter sensory store, attention is an important prerequisite, for without it the entire memory process is short circuited. In this first stage of memory, information is not retained, keeping a memory trace for only a fraction of a second. During intake, selective attention is given to incoming stimuli and its critical features are analyzed, identified, and integrated in the transition process to the second stage of memory, short-term store (Williams, 1973).

After stimuli are taken into sensory store, continued rehearsal or manipulation of information is necessary to keep that input alive. According to Miller (1956), short-term memory can assimilate approximately  $7 \pm 2$  bits of information in 30 seconds. In order to increase

the short-term memory capacity for incoming information, Miller suggests that an organizational process called "chunking" takes place. Chunking involves the recoding of information into groups which are then perceived as a unit. This recoding can facilitate the retention of relatively large amounts of information (Donahoe and Wessels, 1980).

Short-term memory is not only limited in assimilation capacity, but also in the length of memory trace. Shortly after active rehearsal ceases (within 10 to 20 seconds) or with the introduction of 10 to 12 new items, the memory trace decays unless the information has been transferred to the next stage, long-term store (Williams, 1973).

As far as is known, long-term store is not limited in the ways that short-term memory is--input capacity or trace duration. The primary difficulty is provision of adequate rehearsal or reorganization of input in order to assure storage and retrieval. It is believed that the rehearsal process, including chunking of input, aids transfer of information from short-term to long-term store. This rehearsal process may also be the critical stage for introduction of retrieval cues which will later aid recall (Donahoe and Wessell, 1980; Wood, 1972; Peterson and Peterson, 1959).

In view of this previous model, experts in memory have recommended various strategies for aiding retention. One suggestion is to chunk or organize bits of information in order to increase short-term store capacity (Anderson, 1980). While there are numerous methods for chunking information, one very successful and seemingly simple method is the use of a mnemonic system (a formula or aid which helps remembering). According to Norman (1976), the power of a mnemonic system



is the result of reducing long lists of unrelated material into short related lists. Through chunking, the verbal elements are kept within the span of short-term memory.

While mnemonics are often associated with learning pairs of non-sense syllables in a laboratory situation, according to Anderson (1980), the use of a mnemonic strategies has implications outside of research:

In many situations we have to associate various combinations of terms that do not have much inherent meaning. We have to learn shopping lists, names for faces, telephone numbers, rote facts in a college class, vocabulary items in a foreign language, and so on. In all cases we can improve memory if we transfer the task into one of associating the items meaningfully.<sup>5</sup>

Besides initially organizing the information, Tulving and Donaldson (1979) believe that the mnemonic devices used during the encoding process may later act as an effective retrieval cue--"Successful retrieval depends upon the presence of stimuli that provide information that was present at the time of encoding."<sup>6</sup>

There are certain drawbacks to mnemonic systems, however. The main objection is that the subject must learn the mnemonic device as well as the information to be learned. While this is true, Norman (1976) points out that through the addition of images or assertions, the original number of meaningful units may be reduced to a smaller, more manageable number. Another drawback is that certain mnemonic strategies are specific to certain types of memory tasks (Wingfield, 1979).

While isolated practice of memory strategies is of questionable value, memory, and methods which will enhance retention are of great importance to educators. According to Donahoe and Wessells (1980):

Even momentary reflection reveals that learning and memory are in fact different aspects of the same phenomenon. Remembering involves retaining the effects of experience over time, for learning is said to occur when the events that take place at one time during an organism's life influence the behavior of that organism at some later time. Thus memory is implicit in all learning . . . . To go one step further (sic), memory is necessary for learning.<sup>7</sup>

The model of normal memory processes is of great interest to those who work with the learning disabled, for it suggests possible areas of memory "breakdown." This model in turn provides clues for possible teaching strategies to ameliorate these memory problems. Lerner (1976) lists three areas in which memory problems can occur: reception, storage, or retrieval.

Poor reception, associated with sensory store, may result from insufficient attending skills. In addition to fluctuating attention, the student may be less effective in filtering out irrelevant stimuli than nondisabled children. Since attention is "probably a prerequisite for adequate learning . . . inattention and poor short-term memory may be responsible for slower acquisition in learning disabled children."<sup>8</sup>

Failure of storage, associated with rehearsal methods during short-term store, and finally transmission to long-term store may be a result of poor encoding and retrieval methods. Recent studies have indicated that developmental changes occur in the self-initiation of verbal rehearsal and mnemonic strategies and that learning disabled students may have a lag in this skill (Reid and Hresko, 1981). Bauer (1979) suggests, however, that provision of such strategies, along with explicit instructions for their use, may result in significantly improved recall.

Finally, ability to recall stored information may be hampered by inadequate retrieval cues. According to Wood (1972), the discrepancy that sometimes occurs between information that is accessible and that which is available, supports the importance of retrieval cues in the recall process. According to Donahoe and Wessells (1980), the interaction of encoding and retrieval is an important part of the presentation of stimuli that are to be remembered. For successful retrieval to occur, the stimuli that provide information must be present at the time of encoding. Additionally, Anderson (1960), Hagen et al. (1978), and Tulving and Osler (1968) emphasize the importance of retrieval cues in aiding recall performance.

In considering musical presentation as a potential remedial method to aid retention, one must briefly consider the memory process in view of melodic-rhythmic input. "Insofar as is known, the ability to recall or have memory of, the auditory sensation of music is not unlike the memory process for any other sensory experiences."<sup>9</sup>

If musical stimuli are actually processed in a manner similar to normal speech, what might justify the musical presentation of information to enhance recall? While the processing itself might be similar, the content of music has some specific structural characteristics which may facilitate the memory process: (a) rhythmic regularity and (b) tonal organization.

According to Robinson and Solomon (1974), rhythm provides a pattern or structure which punctuates the reference points to which words or digits can be attached--a temporal cuing system. A rhythmic framework can be imposed on seemingly unrelated sequences of information, furnishing new integration and organization.

Even in normal speech patterns, a sense of order and unity is provided through inflections and pauses (such as phrases, clauses, sentences, and paragraphs). When a metrically regular pattern is imposed upon speech, there is not only chunking of words into units or bits, but there is also increased predictability or anticipation of upcoming information through regularity and redundancy (Bloomsletter and Creel, 1977). Metric regularity limits the number of potentially correct responses within a particular time frame. This method describes what Bolton and Bower (1965) call the metric mnemonic --a place-keeping feature which helps the listener keep track of the number and order of stressed syllables in each line.\*

Increased predictability, or ability to anticipate uncoming sounds, is sometimes referred to as expectancy, a concept which plays an important part in melodic, as well as rhythmic, organization of music. According to Carlsen (1981):

Theories in aesthetics (Meyer, 1965) and in perception (Bruner and Postman, 1949; Carlsen, 1969) have been proposed which are based upon the concept of perceptual expectancy and its degree or lack of fulfillment. Most persons will recognize the phenomenon of expectancy as that experience of anticipating what will occur within an event even though the event may be unfamiliar one. In music, a strong preparation for an authentic cadence generates an expectancy for finality. When the cadence occurs, our expectancy is fulfilled, whereas if that preparation leads to a deceptive cadence, our expectancy for closure is left unfulfilled.<sup>10</sup>

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\*Bolton and Bower (1965) and Wingfield (1979) emphasize the importance of rhyming final syllables in each phrase in conjunction with the rhythmic grouping of verbal information. Therefore, one might question the effectiveness of a rhythmic mnemonic which does not include the rhyming factor. It is possible, however, that tonal or organizational aids, such as cadences, may assist the rhythmic grouping's place-keeping function in the absence of rhyming syllables.

Within a musical culture, certain melodic fragments become such a regular part of musical vocabulary that these melodic cliches have a high level of expectancy to the listener (Radocy, 1980). According to Williams (1973), when melodies derived from such high expectancy interval combinations are heard, there is a high level of association with past musical experience and, hence, a higher rate of retention.

Thus, when a melodic-rhythmic framework is imposed upon normal speech as a mnemonic device, two processes are at work: (a) the chunking of information into manageable units; and (b) increased expectation, or ability to anticipate stimuli through metric regularity and highly idiomatic melodic fragments.

In summary, in order to develop effective musical mnemonics for the learning disabled, one must consider the following: (a) in the normal memory process, input capacity and transmission to long term store can be aided by rehearsal using mnemonics which organize or chunk input; (b) while learning disabled students seem to lack initiative in using verbal rehearsal or mnemonic strategies, yet such strategies, if used appropriately, may enhance retention; and (c) the rhythmic and tonal organization of music may act as a mnemonic device which aids the encoding and retrieval stages of memory.

### Definitions

#### Cuing

An operational definition for purposes of this study conforms with methods used in related memory studies (Anderson, 1960; Hagen et al., 1978; Tulving and Donaldson, 1972). It consists of a portion of

the initial stimulus (as it appeared during the rehearsal process) presented as a prompt at the time of desired recall.

### Echoic Memory

Echoic memory is the name commonly used in the field of cognitive psychology for auditory sensory memory. Wingfield (1979) describes it as the experience of being able to mentally hear a sound again. Because auditory events are presented sequentially, changes in frequency, intensity, etc., make up the information which may vary temporarily. The main purpose, according to Lachman, Lachman, and Butterfield (1979), of echoic memory is to preserve temporal patterns. In the field of psychoacoustics, this auditory memory is sometimes called eidetic auditory memory (Radocy and Boyle, 1979). In the field of learning disabilities, it is often called reauditorization.

### Etiology

The cause or origin of the learning disability, whether it be minimal brain damage, perceptual handicaps, hyperactivity, or any other causal factor is etiology.

### Mainstreaming

According to Lerner (1976),

. . . mainstreaming is a delivery system that integrates handicapped children into regular classrooms. Central to the mainstreaming movement is the theme that, given the desire, facilities, and reasonable professional preparation, the average teacher can learn to educate exceptional youngsters in the regular classroom with the support and consultative services of special education personnel (Birch, 1974, p. 1).<sup>11</sup>

It includes the concept that each child should be educated in the least restrictive environment suitable for their educational and related needs.

### Mathematical Facts and Calculation

For the purpose of this study, this includes only learning of basic facts of single digit multiplication. It does not include procedural methods such as borrowing and carrying.

### Melodic-Rhythmic Mnemonics

These mnemonics display two organizing features: rhythmic regularity or meter and tonal melodic sequences.

### Melody (Structural Characteristics)

In its broadest sense, melody means any succession of single tones (Ortmann, 1926) . . . the pitch and durational relationships among the tones contribute to each melody's individuality. A particular tonal and temporal structure creates a constant melodic contour that we perceive and to which we respond. The melodic contour is a Gestalt or holistic pattern to which we respond.<sup>12</sup>

### Meter

According to Cooper and Meyer (1960), "Meter is the measurement of the number of pulses between more or less regularly recurring accents."<sup>13</sup>

### Modeling

For purposes of this study, modeling refers to the process in which the experimental tester shows an example of desired cognitive behavior in order to encourage similar behavior from the subject.

### Rehearsal

This term

. . . denotes the repetition of a verbal item--either immediate or delayed, silent or overt, deliberate or voluntary. The initial perception of a stimulus probably must also qualify as a rehearsal.<sup>14</sup>

### Rote Learning

The phrase rote learning refers to both a process and a product. The process is one of repetition of the same sequence of words, as in learning a poem or the lines of a play or the basic facts of addition or multiplication. The product is a ready recall of the exact word or number sequences that were learned.<sup>15</sup>

### Rhythm

The New College Encyclopedia of Music defines rhythm as "the organization of music in respect to time." According to LaRue (1970), it results from "changing combinations of duration and intensity within all elements and dimensions of (musical) growth."<sup>16</sup>

### Short-Term Memory Task

Norman (1976) describes it as the presentation of a specifically ordered list of stimulus items. The use of a short distractor, which can consist of either an irrelevant task or presentation of later stimulus items (for the retention of earlier items), precedes the written or verbal posttest to determine amount and accuracy of recall.

Test content often consists of serial lists (lists of digits, unrelated words, or nonsense syllables) or paired-associate tasks, where the subject must recall the correct pairing of two unrelated words. Recall follows rehearsal within a short period of time, thus calling on short-term memory skills.



Recall for items can consist of free recall, serial recall (items must be reported in the same order as presented), ordered recall (in which the items can be reported in any order, but the subject must also report the correct position of each item), and probed recall in which the subject receives a cue for items (sometimes a portion of the item itself).

### Strategy

A particular method, device, or special approach used to aid assimilation of a learning task is a strategy.

### Tonality

While a succinct definition of tonality is inadequate, the definition which appears in the Oxford Concise Dictionary of Music (1964) is "the observance of what may be called 'loyalty to a tonic,' i.e., to the key scheme of a composition." The concept of tonality is strongly related to cultural norms in Western music in which a type of a priori arrangement of tones in relationship to one another exists.

## CHAPTER II

### SURVEY OF RELATED LITERATURE

The use of music as a retention aid for exceptional children has been the focus of numerous studies for over two decades. For example, professionals working with the mentally retarded have noted with surprise the ability of clients who generally exhibit limited memory capacity to remember lengthy lyrics if accompanied by music. In response to this observation, music therapists have carried out systematic studies to investigate the potential of music as an aid to recalling academic information.

While the learning disabled have many learning characteristics different from retardates, both groups exhibit problems with memory. Based on the studies of the mentally retarded, music has been suggested as a potential memory aid for the learning disabled as well. However, very few studies are available which examine music as a retention aid with the learning disabled; thus numerous questions remain.

This review of related literature will cover the following subjects: (a) normal memory processes, (b) musical memory as it relates to normal memory, (c) psychoacoustic research on musical and musical/verbal memory of normal subjects, (d) research on musical/verbal memory with the mentally retarded, and (e) special characteristics and needs of the learning disabled, available research findings, and need for further study.

In this study, music is not acting as an aesthetic entity, as is often a major goal in traditional music education, but rather as a rehearsal method for aiding an extra-musical cognitive goal--specifically, improved retention. Therefore, the review of literature encompasses not only research on musical memory, but also research which examines human memory processes. In addition to literature on normal memory activities, the selection of learning disabled subjects necessitates consideration of abnormal memory processes as well, since many learning disabled students may exhibit memory patterns which digress from the usual. In short, pertinent literature reflects the interaction of normal human memory processes in conjunction with musical stimuli and the resulting effect on retention of academic information in the learning disabled.

#### Normal Memory Storage and Retrieval

The study of human memory is both complex and multifaceted and has been the focus of extensive research by psychologists, biologists, and educators. In educational tasks, since learning involves retention over time, memory is implicit in the learning process (Donahoe & Wessells, 1980). Due to the scope of cognitive research related to the study of memory, it is impossible to review the research in its entirety. The literature cited in this chapter will be limited to those pertinent studies of short-term memory and recall facilitation.

Though many questions on memory remain, there does exist a generally accepted model of the three stages of verbal memory: sensory store, short-term store, and long-term store. While long-term store has the advantage of unlimited storage capacity and length of memory

trace, short-term store is limited both in input capacity and length of memory trace. This limitation is an important factor in the efficiency of the memory process; thus, much of the research on retention focuses on short-term memory. Additionally, some researchers see the rehearsal process during short-term store as a crucial activity in transferring information to long-term store (Peterson & Peterson, 1959).

Research by Miller (1956) appears at the base of numerous studies on the limitations of short-term memory. His research describes the input capacity of short-term memory as limited to seven (plus or minus two) unidimensional bits of information within a 30-second time span. Despite this seemingly severe limitation, the mind's ability to reorganize or chunk bits of information allows much greater memory capacity than is initially apparent. Through chunking or reorganizing separate bits of information, large amounts of information can be restructured into a more easily assimilated input format (Donahoe & Wessels, 1980).

In attempts to increase memory capacity, psychologists have studied various strategies for chunking input, including metrical organization. According to Robinson and Solomon (1974), rhythmic structure provides reference points to which digits or words can be attached. Through such rhythmic groupings, the subject can recall approximately as many small groups of information as individual items without grouping (Seashore, 1919). Because memory of auditory events, such as a spoken sequence of words, is displayed in a temporal manner (Underwood, 1976), provision of easily retained groupings can assist auditory or echoic memory.

Bower (1970b) describes rhythmic chunking in the following manner:

One of the fundamental strategies used by people in learning a long series of symbols is to segment it into several smaller chunks or groups. Even a monotonous series can be grouped by the person imposing on it his own rhythmical stress or pauses . . . . This segmentation of a string may serve several useful purposes. First, the segments are small and are themselves easily learned, so the person's job is reduced to serializing a smaller number of units than was true before groupings were imposed. Second, the size of the successive groups and their order in the string may conform to a simple, repetitive, rhythmical pattern which helps the person to plan and execute his serial reproduction (cf. Neisser, 1967). The beats of the rhythm might serve as subjective anchor points to which digits are attached, and the pauses serve as phrase markers delineating major constituents.<sup>17</sup>

While chunking, or rhythmic grouping, happens in normal speech patterns (Restle, 1972), the regularity or constancy of an imposed rhythmic pattern is advantageous in facilitating recall due to what Bower (1970b) terms a "reallocation hypothesis." When repetition of input contains the same group structure as previous presentations, this input "string" is allocated to the previous memory "location," and that trace is strengthened. In contrast, inconsistent or variable input of the input "string" fails to show the same immediate recall improvement (Dowling, 1973; Waters & Waters, 1979; Bower, 1970b).

According to Boomslinger (1977), metrically regular language extends the capacity of language perception because it is regular and repetitious, thus making the expectation of the time scheme easier. "Rhythm's importance to educators comes from its function as organizer of meaningful thought groups . . . . In metrical poetry, language is strongly organized (and) abundantly connected."<sup>18</sup>

Besides the chunking of information, verbal rehearsal also takes place in short-term store. This activity not only prevents trace

decay, but may also aid transition of information to long-term store (Anderson, 1980). Whether this rehearsal is silent inner speech or overt audible speech, verbal rehearsal is a particularly effective mode when dealing with language (Norman, 1976).

Norman differentiates between coding characteristics of short-term store, which are predominantly acoustic, and those of long-term store, which are largely semantic. Since letters or digit groups have little semantic content, acoustic, or articulatory coding may predominate in this type of memory task.

There is some disagreement as to how coding takes place in the memory trace process. Bower (1970b) suggests that the memory trace established is not of an acoustic nature (monitored by the subject's own ears), but rather a proprioceptive muscle memory in the mouth region which recalls the physical properties of various phonemic shapes. The act of verbal rehearsal requires active attention to the information, thus circumventing interference of competing stimuli.

The successful memory process consists not only of information intake, but also successful retrieval of that information at the desired moment. Tulving and Donaldson (1972) and Tulving and Osler (1968) have found that retrieval cues facilitated to-be-remembered words, but only when those cues were stored in conjunction with the information during the learning process. As Donahoe and Wessells (1980) explain this process, "Successful retrieval depends upon the presence of stimuli that provide information that was present at the time of encoding."<sup>19</sup>

In summary, facilitation of memory storage and retrieval is aided by the following procedures: (a) increased short-term memory input

capacity through chunking or grouping of incoming information, (b) consistent presentation of repeated input in order to strengthen available memory traces, (c) adequate rehearsal to prevent decay and to promote transfer into long-term storage, and (d) provision of adequate cues during the storage process which will later aid information retrieval.

### Musical Memory as It Relates to Normal Memory

Memory for musical stimuli falls into several research categories: memory for musical stimuli without accompanying speech, memory for musical stimuli and speech or sung speech, and musical stimuli as an aid to memory. In the selection for musical stimuli which might aid retention, it is important to understand the basic organizational structures of musical stimuli without speech, focusing on the processes which enhance recall.

The memory processes of stimulus input, establishment of a memory trace, and storage are believed to take place in musical as well as speech recall (Bartlett, 1980). As is the case in hearing normal speech, the various sensory impressions must be organized into meaningful units in order for recall to take place. This organization is facilitated in music through rhythmic groupings, melodic contours, and tonal structure. According to Radocy (1980), "Rhythm connotes some sort of recurring and, within limits, predictable event . . . (In music, rhythm provides) the pattern of organized sounds and silences. To perceive a rhythm is to relate the respective durations in order across time."<sup>20</sup>

This rhythmic grouping provides the same function as in verbal material by helping the listener organize and recall pitch sequences. These metric groups tend to have more regularity and redundancy, however, than the pauses or tempo fluctuations that occur in natural speech patterns. Through this metric regularity or constancy, anticipation of upcoming sounds across time is facilitated.

In addition to rhythmic groupings, music is organized according to pitch sequences. When such pitch sequences are recognized by the listener as an aesthetic whole, or a musical Gestalt, this pitch sequence is considered to be a melody. While melodies vary from culture to culture, Lundin (1967) notes three general melodic characteristics: (a) propinquity (closeness of pitch between successive intervals), (b) repetition (tendency to return to certain pitches), and (c) finality (extensive use of authentic or half cadences for musical closure). Recognition of a melodic sequence is the perception not only of specific intervals, but also pitch range and contour.\*

Research on recall for melodies is concerned largely with the recall of pitch sequences, identification of a tone as belonging to a sequence, and recognition of altered melodies (Radocy, 1980). Exactly what makes certain melodies more easily recalled has proven difficult to pinpoint. In long-term memory for familiar melodies, exact interval as well as contour plays an important role. Contour, however, appears to be a greater facilitator of short-term memory than specific interval recognition, especially for transposed melodies (Dowling &

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\*Contour refers to the pattern of successive pitches which makes up a melody.



Fujitani, 1971). In comparing the recall of various melodic contours, those melodies with M-shaped contour appear more easily recalled than melodies with V-shaped pitch relationships (Long, 1977).

Other factors that affect recall for tones within a melodic sequence include the delay time between the stimulus termination and subject response, the tone's position within the entire sequence (serial position), and the sequence length. Delay of response (Williams, 1975) or interfering tones played between the stimulus and the response (Deutsch, 1977) produce deleterious effects on recall efficiency. Serial position effects demonstrate that within pitch sequences, the most recently heard pitches are recalled most easily and middle sequence pitches are recalled with the least accuracy. In general, the longer the pitch sequence, the more difficult recognition of a single tone within the sequence becomes. This serial position effect, sometimes called primacy-recency effect occurs not only in response to musical sequences, but also in word sequence tasks as well. This phenomenon is an excellent example of how musical memory is similar to memory for verbal stimuli.

While many questions remain concerning processing and memory for melodic stimuli, it is suggested that tonal sequences are more easily recalled than atonal sequences (Zenatti, 1975; Long, 1977). Tonality is a concept closely related to melodic organization, since certain melodic pitch relationships or interval patterns appear over and over within a tonal framework. Zenatti describes tonality (or tonal acculturation) as a feeling of familiarity with melodic formulas, chord progressions, and intervals frequently used in our Western music.

Deutsch (1977) describes these pitch relationships as organized in a hierarchical fashion with a priori probabilities established for both linear and harmonic pitch sequences. The typical musical patterns of a culture "serve as overlearned perceptual 'frameworks' in terms of which melodies are encoded."<sup>21</sup> This framework enhances anticipation of upcoming musical events as well as recall for melodic sequence. According to Zenatti, this tonal acculturation of melodic patterns is developed around six to eight years of age.\* Therefore, in children past age eight, tonal organization becomes a potential aid for melodic recall.

Based on these studies, the choice of melodic material which might aid the retention of verbal information would be metrically regular melodies based on atonal structure. However, the implications we can make for music in conjunction with speech are limited for the following reasons: (a) according to Mayo (1981), the processing of melodic patterns which accompany sung speech may not be exactly like either the processing of speech or music without speech; and (b) many of the studies for melodic memory actually investigate memory for isolated pitch as opposed to full melodic Gestalts. In view of these limitations, it becomes important to examine those studies which investigate music as it interacts with speech.

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\*Although music has at times been called "the universal language," in terms of tonal acculturation, this is far from the case since major cultures have their own established melodic formulas and harmonies.

Psychoacoustic Research on Musical and  
Musical/Verbal Memory of Normal Subjects

Investigation of music as an aid to recall of music with speech includes studies carried out by Prickett (1974), Jellison (1976), and Sims (1981). Prickett isolated the rhythmic component of music as a potential aid in recalling serial lists of digits. Using Miller's (1956) research in short-term memory limitations, Prickett limited digit lists to seven items. The subjects, first grade children, were asked to repeat the lists after listening to those lists with either a steady quarter note pulse or an imposed rhythmic pattern.\* The imposed rhythmic pattern resulted in significantly greater retention at the .05 level. Prickett concluded from the study results that imposed rhythmic groupings aided retention of verbal input in a serial list format.

Sims' (1980) investigation is similar to Prickett's research in that both studies utilized serial lists of seven items and both studies isolated rhythm as a treatment mode. Sims' research differs in several aspects: nonsense syllables were used as opposed to digits, adult subjects were selected, and the subjects were then classified as music major or nonmusic major. In addition to comparing recall following verbal or rhythmic treatment, melodic presentation was also compared. Melodic sequences consisted of a self-composed pitch pattern using five pitches (A through E in A major tonality) presented either in a steady quarter note pulse or superimposed upon the same rhythmic pattern which appeared in the rhythmic treatment condition.\*\*

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\*  $\frac{6}{8}$  

\*\*  $\frac{4}{4}$  

Both rhythmic and melodic-rhythmic presentation proved nonsignificant in comparison to verbal presentation for both musicians and non-musicians. The only statistical significance resulted from differences in recall accuracy among lists.\* Because the Prickett and Sims' studies differ on several variables, interpretation of the difference in results becomes difficult. It is possible that adults were less responsive to rhythmic grouping than were children. In view of research on memory processes, it is more probable that the rhythmic organization acted more effectively as a retention aid with digits as opposed to nonsense syllables. According to Wingfield (1979), mnemonic systems are specific to certain types of memory tasks. Thus, it is also possible that the method used for retrieval of information was more difficult in one of the studies. For example, free recall may be less difficult than recall which requires a specific order of items (Norman, 1976). Additionally, it is possible that the rhythmic pattern used in Prickett's study was more effective in grouping the serial lists than the rhythmic pattern used in Sims' research. In summary, the many variables which differ between the two studies makes comparison of studies and their outcomes extremely difficult.

Jellison's (1976) research studying recall of digit lists is unique among these studies, in that verbal and musical input were carried out through a dichotic listening format. In this type of format, left and right ears are presented with different input through

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\*Despite the supposed lack of relationship among items on the lists, it appears that subjects, in order to provide some sense of meaning or organization, imposed their own relationships among these nonsense syllables.

the use of earphones. Through this method, cerebral dominance for verbal or musical stimuli can be examined.

The memory task for this study consisted of lists of seven digits either spoken or sung (with each digit presented in a steady pulse every half second) to melodies composed by Jellison. These melodies were arbitrarily composed using a limited number of pitches (A3 to G4) in a tonal framework (C major tonality). Among the findings, sung speech did significantly facilitate digit recall for both musically trained and untrained subjects, though musicians showed a slight superiority of recall over nonmusicians in the musical treatment condition.\*

While these studies all examine normal subjects' recall of seven item serial lists in verbal, rhythmic, melodic, or rhythmic/melodic presentation modes, the results are inconsistent. Only Prickett's study supports the effectiveness of rhythm alone as an aid to short-term memory. While Jellison's study found melodic patterns to aid retention, Sims' study did not. Once again, perhaps Jellison's choice of digits for a memory task was more appropriate for a musical mnemonic than Sims' choice of nonsense syllables. Perhaps replication of these studies may shed further light on the results, but at present these research results remain inconclusive. Additionally, implications for populations that exhibit serious memory problems must be drawn with great reserve. It is therefore important to consider research findings more directly involving exceptional children.

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\*The following criteria defines a musically trained subject: (a) music major, (b) instrumental or vocal studies for at least four out of the last five years, and (c) participation in an ensemble or individual performance within the past year.

Research on Musical/Verbal Memory  
with the Mentally Retarded

The bulk of research using music as an aid to retention has been carried out with the mentally retarded. As in the research with normals, serial lists have been used to examine short-term recall. Studies by Wilson (1971) and Myers (1979) both utilized paired-associate lists in verbal, melodic-rhythmic, or rhythmic presentation.

Myers' study (1979) was based on the theory that intensive training and rehearsal, grouping and mediational techniques, and overlearning material would improve performance of memory tasks. Melodic-rhythmic presentation was used as a mediational technique and compared to rehearsal using normal speech. The results showed no significant difference between musical and verbal rehearsal. Myers added, however, that since the musical presentation did not impede recall, it, therefore, might provide some variety in teaching approach.

In Wilson's study (1971), paired-associate lists were presented with short, self-composed rhythmic patterns, and additionally with those same rhythmic patterns superimposed on self-composed melodic sequences. Visual aids were utilized in conjunction with the presentations. Subjects were not required to overtly rehearse the lists. Rhythmic presentation alone resulted in no increased retention compared with speech presentation. Though not statistically significant, a trend toward improved retention was reported from the melodic-rhythmic presentation.

The memory task in Crowe's study (1977) differs from that of Wilson or Myers' in the choice of memory task. Rather than selecting serial lists, Crowe presented a specific sequence of colors in a song

and also in verbal instructions. Following this presentation, subjects were asked to place four different-colored geometric shapes in the proper positions based on the previous instructions. During the experiment, subjects were exposed to two presentations of the color sequence in one of the following orders: verbal/verbal, verbal/musical, musical/musical, and musical/verbal. Subjects were not required to sing or repeat the information during the treatment. Neither the mode of presentation (musical versus verbal), number of presentations (one or two) nor interaction of presentation methods (musical with verbal) resulted in statistically significant results. The only factor to show statistically significant results was the individual subject's functional level: higher mental age of subjects correlated positively with higher recall in all presentation methods.

The results of these three studies provide minimal support for use of music as an aid to retention. While musical presentation did not interfere with recall, only musical-rhythmic presentation in Wilson's study showed a trend toward improved retention. Several points should be considered, however. Repetition is a mainstay of academic programming for the mentally retarded. It is possible that such brief exposure to stimuli did not provide adequate repetition or rehearsal in order to gain measureable improvement. Secondly, because the subjects were not required to overtly rehearse the memory task, the attentional aspect of memory may have been inadequate to facilitate initial sensory store and maintenance of information in short-term store. Thirdly, the absence of rhyming syllables may have rendered the musical mnemonic ineffective. Fourthly, the abstractness of the memory task (paired associate lists which have little or no

meaningfulness as a unit), while moderately difficult for a normal subject (who may have the cognitive skills to devise his/her own organizational structure), may constitute a much more difficult memory task for a mentally retarded subject.

It is worth noting that while the musical presentation did not show statistically significant improvement, neither did this method impede recall. Studies by Madsen and Forsythe (1973), Steele (1968), and Madsen, Cotter, and Madsen (1968) have shown that music can act as an effective motivator in academic situations. Therefore, if musical methods do not impede recall and in addition have a motivating effect, musical methods may still merit use as an educational tool. This issue deserves further investigation.

Studies by Isern (1958) and Lathom (1970) which examine music as an aid to retention differ from the studies by Crowe, Wilson, and Myers in the type of memory task and recall response. Rather than utilizing serial lists or color names, information of a meaningful nature was presented through songs, stories, or poetry.

Isern (1958) hypothesized that the "feeling state"\* of music may produce improved memory in retarded children due to increased reinforcement, increased attention, and greater organization of the listening experience. In order to test this hypothesis, a song was sung to each subject. Immediate recall was tested by the number of song items recalled. A story was then presented, and recall tested in the same manner as the song. Testing was done both three days later (recent recall) and three months later (remote recall) for recall of song or

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\*Isern provides no definition or detailed discussion of this concept.



story items. In all tests, musical presentation resulted in significantly greater recall than story presentation, including a greater level of accuracy among those items recalled.

It is difficult to draw conclusions from these results since the researcher provides very little detail about subject selection or procedural methods. Furthermore, no information on song or story selection or methods for collecting responses is available to the reader.

Lathom's (1970) study "Retarded Children's Retention of Songs, Stories, and Poems" also uses stories and songs as methods for presentation and does provide much fuller detail on procedure and subject selection. Subjects chosen for this study included retarded children of mean age 13.5 years with a Measured Intelligence of Level II or Level III (I.Q. ranging from 25 to 54). All songs, stories, and poems used in the study were selected by experts in music and children's literature who verified that these materials were interesting and suitable for the mental age of the subjects. The amount of repetition or redundancy in all materials were judged by two experts in information theory.

Treatment consisted of six half-hour periods of training with two presentations each of song, story, or poem. Visual aids were used in conjunction with all presentations. On the following day, individual tests for retention were given which included recall, chaining, and verbal concepts.

The retention of information within the songs as compared to stories or poems was statistically significant at the .01 level. While the level of Measured Intelligence was an important factor, a higher level of Measured Intelligence resulted in consistently greater

retention scores across all groups. The degree of repetition within materials was found to be an important factor: Lathom concluded that redundancy facilitated recall.

Lathom based her research hypothesis on information theory. According to this theory, a message which contains novel or unexpected input is high in new information, as opposed to redundant or predictive stimuli, which adds little new information. In successful communication, a balance between totally novel and highly redundant information level is desirable. Some degree of redundancy short of monotony facilitates understanding, while a novel stimulus provides an adequate interest level. In music, redundancy results from idiomatic, culturally familiar melodic or rhythmic sequences, while the wide variety of available musical vocabulary provides new information. According to Lathom, this balance is ideal, making music an excellent facilitator of meaningful communication.

Similar to the studies reviewed on retention in normals (Prickett, 1974; Sims, 1981; Jellison, 1976), results of those reviewed studies with the mentally retarded (Wilson, 1971; Myers, 1979; Crowe, 1977; Isern, 1958; Lathom, 1970) are inconclusive. Certainly many factors might contribute to inconsistent findings: subject selection, rehearsal method (active or passive), amount of exposure to stimuli, chosen response mode, and the nature of the memory task itself.

In reviewing these studies done with the mentally retarded, it is important to note the difference in meaningfulness among the memory tasks. In the studies by Lathom and Isern, to-be-remembered information consisted of entire songs and stories with meaningful information as opposed to the nonmeaningful serial lists in the research of Wilson

and Myers. Researchers in the field of memory know that meaningful information is more easily recalled than that which is not. In addition, various types of mnemonic strategies are more or less appropriate for different memory tasks (Wingfield, 1979). Thus the teaching strategy selected for remediation should be evaluated in terms of specific task requirements. Wingfield (1979) makes the following recommendation for an effective musical mnemonic: "If a rhyme is good, a rhyme with a little melody is even better."<sup>22</sup> The absence of rhyming in the paired-associate tasks (Wilson, 1971; Myers, 1979) may affect the strength of the musical mnemonic. In complete songs, such as those used in the studies by Isern (1958) and Lathom (1970), final rhyming syllables often appear at the end of a musical phrase.

Equally important as the choice of appropriate strategies for specific tasks is the need to evaluate teaching strategies in view of individual student characteristics and needs. To exemplify, when teaching strategies are selected for the learning disabled, based on research with the mentally retarded, there is a failure to acknowledge differences in learning patterns or problems between these two populations. Therefore, it is necessary to consider musical remediation methods specifically for the learning disabled student.

### Special Characteristics and Needs of the Learning Disabled

Essentially, the term learning disabled covers a heterogeneous group of students who, despite normal I.Q. and sensory acuity, have serious learning problems. While this diagnosis covers a multitude of academic deficiencies, there are some cognitive areas which have been

identified as problematic to a large number of this population. One such problem area is memory.

The fact that some children who are unsuccessful learners have poor memories was observed long before learning disabilities was recognized as a field of study. Yet there is now a renewed interest in the role of memory in learning, in the kinds of memory operating within a learning task, and in ways to improve memory.<sup>23</sup>

Because memory is so interrelated with learning (Donahoe & Wessells, 1980), problems in this area can affect a wide range of academic skills. Johnson and Myklebust (1967) have related memory impairment to reading difficulties, since reading requires both auditory and visual memory. They note that problems of attention and memory, while differentiated, often occur together, and that memory span is often deficient in the learning disabled child. They make the following suggestions for cues: (a) cuing the child to "wait, listen" to facilitate attending; (b) emphasizing the rhythmic sequence of words to improve auditory sequentialization; and (c) teaching the student "to organize, revisualize, or reauditorize a task before starting it."<sup>24</sup>

Memory impairment may not be limited only to reading problems, however. According to Webster (1979), there exists a significant difference in short-term memory capacity between those children with adequate math achievement and learning disabled students who are performing below grade level. He cites the ability to recall number tables as one example of recall difficulty and further suggests that the problem may stem from failure to use efficient coding mechanisms in the short-term memory process.

The inefficient coding procedure discussed by Webster is also suggested by Torgesen (1979, 1980), Bauer (1979), and Tarver et al.

(1976, 1977). Torgesen found learning disabled students much less likely than normal children to use verbalization and mnemonic aids spontaneously during study periods or sequential memory tasks. Torgesen sees this inability to generate spontaneously verbal mediational strategies as a developmental lag which results in memory problems and failure to approach cognitive tasks in an efficient manner.

Bauer (1979) concurs that deficient mnemonic processing, coupled with inattention, may be important in that these impede short-term memory in learning disabled children. Poor rehearsal strategies, which initially play an important role in short-term memory, may later hamper the transfer of coded information to long-term storage, since there is speculation that rehearsal or manipulation of sensory input helps this transfer. Bauer suggests that the short-term memory process may be aided through appropriate use of mnemonic strategies.

Verbal rehearsal strategies are a focus of studies by Tarver, et al. (1976, 1977). According to Tarver, selective attention and spontaneous use of verbal rehearsal strategies are considered basic psychological processes which develop with age. In the learning disabled, this process may lag several years behind. And though the learning disabled child may eventually develop equal attentional and rehearsal skills, the academic information lost in the interim hampers academic success (Tarver et al., 1977). In experimentally induced verbal rehearsal strategies, however, selective attention became more efficient, suggesting that environmental manipulation through appropriate strategies and reinforcement may be successful tools to aid retention. Tarver et al. (1977) emphasize the use of repetition,

rehearsal, guided practice in which the instructor models the use of the rehearsal strategy, and reinforcement with the learning disabled.

According to Reid and Hresko (1981), failure to use rehearsal strategies may constitute a production deficiency. This type of deficiency is characterized by a person who has an ability, but fails to use it at the appropriate time. As an example, a learning disabled child may have learned the spelling rule "i before e except after c," but may fail to apply this little rhyme spontaneously at the appropriate time. Rather, the student will tend to use such a mnemonic appropriately only when instructed how to do so.

This same production deficiency can effect rehearsal in the memory process.

Conscious rehearsal is often needed to retain unfamiliar information for short periods, but learning disabled children do not always recognize that verbal repetition is a strategy they can use in maintaining the information. They must be taught to rehearse.<sup>25</sup>

The use of verbal rehearsal can act not only as a rehearsal method, but also as an aid to self-regulation (Keogh & Margolis, 1976; Weithorn & Kagan, 1979; Meichenbaum, 1977). Because many learning disabled children show poor organizational skills and lack selective or sustained attention skills or respond impulsively, remedial programs cannot be limited to orders of "slow down." As Keogh and Margolis point out, strategies must aid in developing more appropriate techniques to use the time fruitfully. They list the following strategies as helpful in developing internal controls: verbal self-instruction, increase of critical cues, modeling or demonstration, verbal analysis and emphasis, and novel or sudden stimulus. Weithorn

and Kagan support the use of verbal self-regulation--especially for children who tend to respond to a task impulsively.

While no single strategy can provide a panacea for the varied problems of the learning disabled, these studies suggest the following approaches which may aid impulsive responses, ineffective cognitive strategies, and inefficient short-term memory strategies: (a) overt verbal rehearsal as an aid to efficient coding of incoming information and as a self-monitoring device; (b) imposed organization such as special or temporal series when presenting lesson material (Reid and Hresko, 1981); and (c) provision of cues to help retrieval of that information, providing reinforcement to actually use a strategy at the appropriate time.

It is not sufficient (for organizational strategies) to be present. Children must be told that it is there . . . . Children, especially those with memory deficits, tend not to discover and impose structure for themselves.<sup>26</sup>

Based on these suggestions, in what way can music fit into memory strategies? Do current research findings provide any answers?

Unfortunately, current research on using music as an educational aid for the learning disabled is very limited. One of the few available studies includes Roskam's research (1977) incorporating music into a reading readiness program. Working from the premise that many children with language-based learning disabilities exhibit minor deficits in auditory discrimination and memory, Roskam assigned 36 learning disabled children (ages six to nine) to one of the following treatment groups: (a) musical activities stressing auditory sequencing or discrimination, (b) the usual prescribed learning disabilities remediation for language development (as prescribed in their usual

classroom program), and (c) a combination of the music activities and prescribed language development remediation utilized in groups (a) and (b).

Pretests and posttests for reading readiness were based on verbal and nonverbal auditory awareness, reading recognition, comprehension, and spelling. Additional data on behavioral appropriateness were also compiled, since many of the subjects also displayed some emotional or behavioral maladjustment. While no statistically significant difference was found between groups, the mean scores for the musical activity group were highest for behavioral improvement and all posttest areas except reading comprehension. Combined music and language development showed the highest mean scores in reading comprehension.

This particular study relies heavily on the theory that perceptual skills can be remediated in an isolated fashion. Recent research in learning disabilities has failed to support this approach. Rather, the most direct and closely related remediation to a learning problem seems the most effective.

Besides the fact that Roskam's study is based on remediation of perceptual skills, it also does not address the cognitive area of memory. Therefore, its relationship to the present study is quite limited. Shehan's (1981) research does, however, give information on retention in that it focuses on the use of verbal, visual, musical, or mixed mediational techniques in order to examine whether not one mediational approach acts as a more effective aid to retention.

In Shehan's study, 16 distractible learning disabled students (ages seven to ten) were exposed to four lists of seven pairs of words presented in the following formats: (a) musical (sung to the interval



of an ascending fourth in an even rhythmic pulse), (b) verbal (spoken at the same even pulse), (c) musical/visual (in which outlined pictures of the words accompanied the sung words), and (d) verbal/visual (in which the picture accompanied the spoken words). Responses were gathered by giving each subject the first word of a pair and asking him/her to state the second word.

The mean scores for each presentation format were as follows: musical/visual--2.31, verbal/visual--2.56, verbal--.69, and musical--1.0. The results, significant at the .01 level, indicated that combined use of musical/visual or verbal/visual teaching strategies best facilitated the retention of paired associates.

While Shehan's study does examine music as an aid to retention, it has several procedural limitations which should be noted: (a) the use of only two pitches (an ascending fourth) as a musical stimuli is a very limited sound source. One could certainly question whether or not only two pitches provide an adequately lengthy pitch pattern or enough sense of finality (through a cadence) to form an actual melodic sequence or aesthetic whole. In fact, Shehan's recommendations for further study suggest the investigation of more extensive melodic stimuli in conjunction with the memory task; (b) Shehan's study provides little information on subject selection. Beyond the subjects' ages and their tendency toward hyperactivity and distractibility, there is minimal information on the subjects to infer the generalizability of research findings; (c) the study focuses on the efficacy of visual, verbal, and musical mediation, yet provides little supporting theoretical basis to explain why musical mediation might prove to be an effective strategy; and (d) the memory task and rehearsal

procedures were limited to one presentation of a paired associates' list. There was no examination of the strategy's effectiveness over time, nor was there provision for overt verbal rehearsal.

Thus, while the results of Shehan's study point to a slightly greater mean score for musical over verbal presentation, and significantly greater recall resulting from mixed mediational techniques, Shehan's study provides limited information on the effectiveness on the effectiveness of music as an aid to retention.

In summary, while several researchers recommend the use of music as an aid to retention, the inconclusive results of many of these studies suggest the need for further investigation, particularly in view of the following issues related to the learning disabled population.

1. Further study must be done specifically with the learning disabled population rather than relying on research findings gleaned from studies with the mentally retarded.
2. Due to the heterogeneous nature of the learning disabled population, there is a need for more detailed communication of specific subject characteristics.
3. In view of the suggested value of verbal rehearsal strategies as aids to encoding and self-monitoring behavior, the experimental procedure should provide for investigation of active, overt rehearsal of musical mnemonic devices.

4. In addition to providing the musical mnemonic, the researcher must consider the importance of thorough and clear presentation of a strategy's appropriate use.
5. Further research must extend beyond examination of nonmeaningful information, such as serial lists, to the investigation of strategy effectiveness within actual academic tasks.
6. More extended measurement of rehearsal and subsequent recall is needed in order to more clearly examine the long-term effects of a possible teaching strategy.

The present study addresses these research needs, going beyond single rehearsal of serial lists to a repeated measure of recall for actual academic tasks with learning disabled students. The research procedure not only provides for the examination of musical rehearsal, and its effectiveness with both normal and learning disabled students, the manner in which a strategy is taught is also considered. In order to adequately take into account the heterogeneous nature of the learning disabled population, subject characteristics in regard to academic, behavioral, and socio-economic factors have been reported.

## CHAPTER III

### PROCEDURE

The purpose of this study was to investigate the effectiveness of musical rehearsal as an aid to retention in normal and learning disabled students. While other research studies have examined music as an educational aid, this study attempted to provide further knowledge on music as a retention aid for learning disabled students by (a) more specifically addressing the learning disabled population and individual academic and behavioral characteristics of this group, and (b) providing procedural methods which examine the effectiveness of music for retention in conjunction with actual academic tasks as opposed to nonmeaningful serial lists. Repeated measures furnish an opportunity to examine the impact of a musical rehearsal strategy over time.

#### Subject Selection

Sixty subjects were drawn from two populations: 30 learning disabled male students and 30 normal male students, ages 9.0 to 11.9 (grades 3, 4, and 5). Selecting students in this age range seemed most appropriate for the memory task studied herein--namely, the multiplication tables, since single digit multiplication is often introduced and practiced in the school grades which include this age range. Additionally, this age range was considered to be advantageous in that several related research studies on verbal rehearsal techniques (Tanner et al., 1977; Hallahan et al., 1974) selected a similar age range

and developmental characteristics. Tarver and Hallahan both consider short-term memory strategies, especially verbal rehearsal, to be a developmental characteristic. Because of the predominance of male learning disabled students reported in the literature (80%--Farnham-Diggory, 1979), only male subjects were included in the study.

In order for a subject to qualify as a learning disabled group member, the subject had to be officially classified as learning disabled by an Individual Educational Program committee report and currently enrolled in either a self-contained or resource room program for the learning disabled.

Normal students selected for the study included students enrolled in regular classrooms and having no official record of handicapping conditions. Furthermore, classroom teachers were asked to include only those students who, in their judgment, possessed no academic deficiencies or serious learning problems.

In order to insure that both normal and learning disabled students met normal intelligence criteria, all subjects were screened using the Slosson Intelligence Test, an individual standardized intelligence screening device. This particular screening device was chosen for the following advantageous features: (a) length--administration time is brief (10-30 minutes); (b) it can be administered by teachers or responsible adults, as opposed to some tests which require a psychologist or psychometrist for administration; and (c) it provides more sensitive measurement of individual I.Q. level than a group test, and for the purposes of this test provided adequate screening information.

Himelstein and Hunt (Seventh Mental Measurement Yearbook, edited by O. K. Buros, 1965) both describe the test as a valuable and quick screening device which is easily administered. Himelstein does suggest caution concerning reliability and validity, but adds that there is significant scale and item content similarity to the Stanford-Binet Intelligence Scale. Questions and response mode are verbal, which is advantageous for those learning disabled students with severe reading problems. The item content is primarily mathematical reasoning, vocabulary, auditory memory, memory, and information (Hunt, 1965).

The publisher reports a reliability coefficient (test-retest) of .97 with a Standard Error of Measurement of 4.3. The intended mean or average for the Slosson Intelligence Test (SIT) is 100, with an average standard deviation of 17. The range for low-average to high-average I.Q. range is 80 to 119. For this study, a lower cutoff point of 90 was chosen in order to filter out possible "slow learners" who may have been inadvertently placed in a learning disabilities program. In addition, this cutoff point provides an extra margin of safety in consideration of inaccuracies due to the Standard Error of Measurement associated with this testing device. An upper cutoff point of 120 was selected in order to limit subjects to upper normal intelligence range.

The test manual for the SIT includes screening of the learning disabled as one use for this test, but adds that such individuals may exhibit "scatter" or inconsistent performance in various portions of the test. In order to provide testing consistency, all screening was carried out by one test administrator--a certified teacher in learning disabilities.

In addition to I.Q. requirements (90-120 on the SIT), all subjects were required to have previous exposure to multiplication concepts and tables as reported by the classroom or resource room teacher. Subjects with 76% or higher accuracy on the pretest were dismissed from the study to insure that subjects would not ceiling out.

Because of the heterogeneous nature of the learning disabled population, it was important to consider not only I.Q., age, and school grade, but also other variables such as race, academic problem area (reading, math, written, language, etc.), behavioral characteristics, and socio-economic status. These characteristics were obtained through a data collection instrument (Appendix A-B) filled out by the resource room or classroom teacher.

The following characteristics were tallied for all subjects: parent occupation, race, whether or not the subject was bilingual, attendance at public or private school, grade, chronological age, and intelligence quotient as measured by the SIT.

For learning disabled students, the following additional characteristics were noted by the resource room teacher through a checklist (Appendix A) of academic and behavioral characteristics: type of learning disability (i.e., reading, math, written language), educational placement (resource room or self-contained room), severity of underachievement in academic problem area and mathematics (if not the area of referral), activity level (hyperactivity or hypoactivity), existing attentional problems, level of severity of attentional and secondary behavioral or emotional problems.

These characteristics were selected as the most pertinent to this study from an extensive list of variables in the article by Keogh et

al. entitled "UCLA Marker Variable Project." This article provides a list of descriptors or markers which can be used in reporting sample characteristics in research on learning disabilities. Characteristics were recorded in order to provide the reader with more specific information about the sample included in this study.

Among the subject characteristics included on the data collection sheet was the subject's socio-economic status. This was determined through the Duncan 1970 Socio-Economic Index (SEI)\* which ranks occupations on a scale of 0 to 100. According to Duncan (1961), this scale may be broken into any degree of coarseness desired; in this study, in which socio-economic variables are a secondary consideration, the decline units were arbitrarily broken into five categories: upper class (80-90), upper middle class (60-79), middle class (40-59), lower middle class (20-39), and lower class (0-19). The SEI score for each subject was established by selecting the highest ranking occupation of either parent.

Because the individual subject's attitude toward music might influence the subject's success in using musical rehearsal techniques, a questionnaire on musical environment and attitude was developed. In designing a questionnaire appropriate for use with the learning disabled, several factors were considered: many learning disabled students have poor or limited attention span, or a tendency toward impulsivity. Some learning disabled students have difficulty with word recognition or reading comprehension; and, finally, because of

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\*The Duncan 1970 Socio-Economic Index appears in R. M. Hauser and D. L. Featherman's The Process of Stratification (New York: Academic Press, 1977).



underachievement in academic areas, it is important to avoid lengthy disruption of crucial classroom time.

Therefore, a questionnaire was designed which would remove the students from the classroom for only a limited time, yet would be maximally informative within time constraints. An interview format was chosen to avoid reading problems, and a closed-form response was chosen to ensure more objective and easily coded data. Finally, age-appropriate language was selected to increase reliability of response.

Most music educators agree that a child's attitude toward, and active involvement in, musical activity are influenced by exposure to music and the musical attitude of close family members. These factors are one area of focus in Gaston's Test of Musicality (1957), which includes a questionnaire on musical experience and attitudes. Since Lehman (1968) reports that Gaston's test was normed for grades 4 through 12 (which makes it approximately age appropriate for this study) and that the test is both carefully constructed and well standardized, this measurement device is a logical model for possible questionnaire items. In examining other questionnaires used in research with children, the importance of Gaston's test becomes apparent, since many of these instruments are updated or revised forms of Gaston's original questionnaire.

One study of particular interest, which uses the Gaston test as a model, is reported by Roskam (1977) who includes an examination of musical environment and attitudes among learning disabled children. Roskam's questionnaire is essentially an updated version of the Gaston questionnaire. While Roskam's revision of Gaston's test appeared an adequate measurement device for her study, she provided no information

on questionnaire development or content validity; therefore, rather than utilizing this pre-existent questionnaire, similar item revision of the Gaston test was prepared specifically for this study. Item coverage was developed using a table of specifications, concentrating on two basic areas: musical environment and attitude toward music (Table 1).

TABLE 1  
TABLE OF SPECIFICATIONS

| <u>Musical Environment--60%</u>  | <u>Available Points</u> |
|--|-------------------------|
| A. Personal active participation<br>in musical events--questions<br>1 and 3        | 5                       |
| B. Family participation in musical<br>activities--questions 2 and 4                | 5                       |
| C. Passive musical activities, such<br>as listening to music--questions<br>5 and 6 | 4                       |
| <u>Musical Attitude--40%</u>   |                         |
| A. Current interest in musical<br>activities--questions 8 and 9                    | 5                       |
| B. Current interest in passive<br>musical activities--questions<br>7 and 9         | 3                       |
|  | <hr/>                   |
| TOTAL POINTS:  | 22                      |

In order to minimize interview time, it was important to select optimally informative items. In an effort to choose such items and to check content validity, potential items were submitted to the following panel of experts from the music education faculty at Michigan State University: Dr. Melanie Stuart, Dr. Robert Erbes, and Dr.

Albert LeBlanc. Based on their suggestions for rank, weight, and validity of questions, final items were chosen (see Appendix D).

The overall subject score for the musical questionnaire was tallied in the following manner: potential points were assigned to each item, with a total score of 22 available. For final analysis of musicality factors, the total score is subdivided in the following manner: high (15-22 points), medium (8-14 points), and low (0-7 points).<sup>\*</sup> It should be noted that the total length of the questionnaire is a small sampling of behavior and thus in danger of low reliability. However, lengthy measurement instrument which goes beyond the optimum attention span of many learning disabled students may be even less effective due to possible inaccurate or imprecise responses.

In addition to characteristics of musical attitude and involvement, subject characteristics such as age, I.Q., and specific type and severity of learning disability were documented in order to provide more detailed information on the test sample.

### Subject Characteristics

Through the use of various measurement instruments and data collection forms, the following descriptive statistics of various group characteristics were tabulated (see Tables 2 and 3).

In comparing the normal and learning disabled groups, only two categories show significant difference between groups: age and I.Q. While the majority of normal subjects in the study were aged nine, the majority of learning disabled subjects were aged ten and still

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<sup>\*</sup>Of those 30 normal and learning disabled subjects in the musical treatment group, 14 subjects measured in the low category, 15 in the medium category, and only one student in the high category.

TABLE 2

FREQUENCIES AND CENTRAL TENDENCIES  
FOR LEARNING DISABLED STUDENTS\*

| <u>Type of Learning Disability</u>   | <u>Number of Students<br/>Per Category</u> |
|--|--|
| Reading  | 5  |
| Mathematics  | 1  |
| Reading and mathematics  | 15   |
| Written language   | 3  |
| Reading, mathematics, and written language                                 | 5  |
| Auditory memory  | 1  |
| <u>Severity of Underachievement in<br/>Reading and/or Written Language</u> |  |
| 1 year   | 4  |
| 1.5 years  | 9  |
| 2.0 years  | 5  |
| 2.5 years  | 1  |
| 3.0 years  | 2  |
| 3.4 years  | 4  |
| 3.5 years  | 1  |
| Mean underachievement = 1.87 years   |  |
| <u>Mathematics Underachievement</u>  |  |
| Above grade level  | 0  |
| At grade level   | 1  |
| Less than one year below grade level                                       | 10   |
| 1-1.5 years below grade level  | 13   |
| 2-2.5 years below grade level  | 4  |
| 2.5 + years below grade level  | 2  |
| <u>Activity Level</u>  |  |
| Hyperactive  | 7  |
| Hypoactive   | 1  |
| Neither  | 22   |

| <u>Attention Problems</u>                          | <u>Number of Students<br/>Per Category</u> |
|--|--|
| None   | 4  |
| Slight   | 12   |
| Moderate   | 14   |
| Severe   | 0  |
| <u>Emotional or Behavioral<br/>Characteristics</u> |  |
| Minor emotional problems                           | 19   |
| Secondary emotional problems                       | 7  |
| Severe emotional problems                          | 2  |
| None   | 1  |

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\*Learning disability characteristics were evaluated by the resource room teachers and are thus subject to their individual judgments.

TABLE 3  
CROSS TABULATION OF FREQUENCIES  
AND CHI SQUARE ANALYSIS

| <u>Category</u>                               | <u>Normal</u> | <u>Learning<br/>Disabled</u> |
|---|---------------|------------------------------|
| <u>Grade</u>                                  |               |                              |
| Third   | 10            | 9                            |
| Fourth  | 15            | 17                           |
| Fifth   | 4             | 4                            |
| Raw Chi Square    2 df    .16073    P = .9228 |               |                              |
| <u>Age</u>                                    |               |                              |
| 9   | 22            | 10                           |
| 10  | 8             | 17                           |
| 11  | 0             | 3                            |
| Raw Chi Square    2 df    10.74    P = .0047* |               |                              |

| <u>Category</u>                      | <u>Normal</u> | <u>Learning Disabled</u> |
|--------------------------------------|---------------|--------------------------|
| <u>Race</u>                          |               |                          |
| Caucasian                            | 24            | 26                       |
| Black                                | 3             | 2                        |
| Hispanic                             | 1             | 1                        |
| Black/Hispanic                       | 2             | 1                        |
| Raw Chi Square 2 df .6133 P = .8934  |               |                          |
| <u>I.Q.</u>                          |               |                          |
| 90-99                                | 9             | 21                       |
| 100-109                              | 11            | 7                        |
| 110-120                              | 10            | 2                        |
| Raw Chi Square 2 df 11.002 P = .004* |               |                          |
| <u>Socio-Economic Index</u>          |               |                          |
| High                                 | 0             | 3                        |
| Medium high                          | 7             | 6                        |
| Medium                               | 7             | 4                        |
| Medium low                           | 4             | 1                        |
| Low                                  | 12            | 16                       |
| Raw Chi Square 4 df 6.2665 P = .1801 |               |                          |

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\*Indicates statistical significance at the .05 level

struggling with multiplication facts. Most 10 year old normal subjects who were screened had already mastered their tables past the 76% accuracy level acceptable for subject inclusion. The learning disabled students had a significantly greater number than normals in the lower I.Q. range. This finding should be interpreted with care, since "scatter" can complicate the interpretation of an overall test score. Subject characteristics specific to the learning disabled group will be discussed in Chapter V in conjunction with experimental findings.

### Overview of the Study

The primary purpose of this study is to examine the effectiveness of musical rehearsal on short-term memory. In order to measure its effectiveness, a memory task was devised which was followed by immediate posttesting for recall accuracy.

Traditionally, the study of verbal memory includes the use of what is commonly called rote learning--word-for-word formulas or definitions. Conceptual understanding may follow, but the memorization process itself is perhaps best described as the chaining of verbal associations. Wingfield (1979) adds that such study is important for two reasons. First, the memorization of an order of words verbatim

. . . illustrates chaining of multiple associations and serves as a vehicle for further development of the principles of learning. The second reason is a practical one. Whether desirable or not, rote learning represents a large bulk of formal learning in the early school years and later.<sup>27</sup>

For this particular study multiplication tables were selected as a memory task since they require the word-for-word or verbatim recall generally associated with verbal memory research. In addition, they have a similar format to paired-associates memory tasks (in this case, the stem of the multiplication problem, such as  $7 \times 9$ , is associated with the correct response, 63), they are easily quantifiable, and yet they constitute an actual academic task learned by third, fourth, and fifth grade students in a normal educational milieu.\*

In order to examine the suitability of multiplication tables as a memory task, in addition to standardizing verbal instructions and data collection methods, two pilot studies were conducted.

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\*Many of the teachers of students in the study corroborated this statement, reporting that they do encourage and drill on memorization of the times tables.

### Pilot Studies

In the first pilot study, nine normal nine year old subjects were selected from the third grade class of St. Andrew's School in Grand Rapids, Michigan. The nine subjects were randomly assigned to one of three treatment groups: (a) normal speech rehearsal; (b) rhythmic speech rehearsal, with the rhythmic patterns from the song "Do, Re, Mi" by Rogers and Hammerstein imposed upon the speech; (c) melodic-rhythmic rehearsal which consisted of rehearsal of the memory task to the song "Do, Re, Mi." The memory task consisted of the table of 7s presented on tape. The table of 7s was selected since the greatest number of calculation errors occurs with the number 6 and higher (Killian et al., 1980).

Subjects participated in a pretest, treatment, and posttest in groups of three, with each group receiving a different treatment condition. The pretest for all groups consisted of 27 cards (with a separate set for each subject) containing individual presentations of the nine multiplication problems included in the memory task. Answers were completed in the written mode with five seconds allowed for response.

Treatment consisted of a sequence of listening, repeating, writing, and once again repeating the nine problems included in the table of 7s. Each group of three rehearsed the problems together, using the specific rehearsal mode to which they were assigned. Immediately following rehearsal for that group, subjects were posttested using the same content and procedure as in the pretest.

Although the n of subjects was too small to carry out statistically meaningful analysis, the mean score for recall improvement was



slightly higher for the musical group ( $\bar{x} = 5.3$ ) than either the normal speech ( $\bar{x} = 2.3$ ) or the rhythmic speech group ( $\bar{x} = 3.0$ ). Several observations were made (a) the students were able to follow the verbal instructions and carry out the treatment task appropriately, (b) the use of a pre-existent song ("Do, Re, Mi") appeared to create a bias as recall accuracy tended to be favorable for those students who indicated familiarity with the song, and (c) the use of a single song for the entire table of 7s prevented alternative sequence of problems. Thus, the problem  $7 \times 9 = 63$  always appeared last during the rehearsal process. This problem also showed the greatest recall accuracy.

Based on these results, the following procedural decisions were made: self-composed (meaning composed by the researcher) rhythmic patterns rather than pre-existent tunes were used in order to use a musical source of equal unfamiliarity for all subjects, and separate short melodic-rhythmic patterns for each multiplication problem were used to facilitate alternative presentation sequences of the problems.

Incorporating these changes, a second pilot study was conducted with nine learning disabled students aged nine and ten from a learning disabilities resource room at Wilcox Elementary School in Holt, Michigan. As in the first study, the subjects, selected by the resource room teacher, were randomly assigned to three different treatment groups: (a) normal speech rehearsal, (b) rhythmic speech rehearsal, and (c) melodic-rhythmic speech rehearsal. The same self-composed rhythmic patterns were used for both the rhythmic speech and melodic-rhythmic rehearsal modes. Nine different self-composed melodies were superimposed on these rhythmic patterns for the melodic-rhythmic presentation of the memory task. A different melodic sequence was used

for each multiplication problem, but all sequences were limited to the pitches C4 through G4. All presentation modes were presented on tape.

As in the first pilot study, each treatment group participated as a unit, with each group participating in testing and treatment at separate times. The instructions, treatment task, and pretest and posttest methods were consistent with those methods used in the first pilot study. While the learning disabled students were able to carry out the various tasks as instructed, the test results showed markedly lower recall accuracy, following a single treatment session compared to recall by normal students. Those learning disabled students in the normal speech and rhythmic speech treatment groups displayed a mean gain of 0.0 in the posttest. While the subjects in the melodic-rhythmic treatment group showed a slight mean gain of 1.1, this is a much lower gain than the recall level for the same treatment used with normal subjects.

Because gains in recall were so limited following a single rehearsal by learning disabled subjects, the use of additional rehearsal sessions (with each session followed by posttesting) was considered. Because repeated practice gives the opportunity for additional items to be learned in each trial (Wingfield, 1979), it was hoped that the learning disabled subjects might show more substantial recall gains by the end of a total of five rehearsals. Repeated rehearsals also approximate more closely actual classroom learning than does a single memory rehearsal. In addition, Reid and Hresko (1981) recommend frequent reviews covering rather small bits of information in each session in order to maximally facilitate retention.

Following the pilot studies, Dr. William Schmidt, professor of statistics and chairperson of the Counseling, Educational Psychology, and Special Education Department at Michigan State University, was consulted in order to review the research design and to establish an adequate  $n$  for sampling. Two procedural decisions resulted from this consultation: (a) in order to remove interactive effects among subjects, it would be necessary to carry out treatment and testing with individual subjects rather than in groups of threes (as was the case in the pilot study); and (b) in order to test all three treatment methods utilized in the pilot study, an  $n$  of 90 subjects would be required (45 normal and 45 learning disabled subjects). The availability of 45 learning disabled subjects of the correct age, I.Q. range, gender (male), and level of mathematics achievement seemed unrealistic within the locational and time confines of this study. Therefore, the decision was made to examine the effect of melodic-rhythmic patterns in contrast to verbal rehearsal, omitting the variable of rhythmic patterns. This examination of two rather than three contrasting methods required only 30 learning disabled and 30 normal subjects for the total sample.

The use of melodic-rhythmic patterns as opposed to rhythmic patterns was chosen as the treatment condition for the following reasons:

1. In both pilot studies, the melodic-rhythmic rehearsal method showed slightly greater mean gains than did rhythmic or normal speech methods.
2. According to the definition of a rhythmic mnemonic by Bolton and Bower (1969), rhyming syllables are a major part of the effectiveness of rhythmic groupings as an

aid to recall. While rhythm along with rhyme was considered as a treatment method, there was concern that the rhyming element may provide memory aids unrelated to the actual rhythmic structure itself (extra-musical associations).

3. The use of rhythmic speech alone has had limited support as an aid to auditory memory. While Prickett's study using serial lists of digits did show improved retention from rhythmic groupings, studies by Wilson (1972), Sims (1980), and Myers (1979) did not support the isolated use of rhythmic structure. Melodic-rhythmic patterns or melodic patterns have shown trends toward improved retention or significantly improved retention in studies by Wilson (1972), Lathom (1970), Jellison (1976), and Shehan (1981).

The major drawback to use of melodic-rhythmic patterns was the inability of some subjects to accurately match the pitches within the melodic sequence. Most subjects, however, were able to approximate the basic contour of the melody.

### The Major Study

#### Preparations and Materials

Following the two pilot studies, final procedural decisions were made and testing and treatment materials were prepared. The memory task selected was multiplication tables for the numbers seven and eight, specifically the facts 7 x 6 through 7 x 9 and 8 x 5 through 8 x 9. These two sets of multiplication facts are subject to greater

number of calculation error than smaller numbers (Killian et al., 1980). In addition, the results of the pilot study showed that the lower multiplication facts for the table of 7s were not particularly difficult, while the higher tables showed high incidence of error on the pretest. Thus, to provide an adequate sampling of problems for sufficient measurement, the upper tables of 8s were included as well as the upper table of 7s.

During the treatment session, these multiplication problems were presented in auditory and visual fashion, using tape recordings and flash cards. This mixed mediational approach was utilized for the following reasons: (a) Shehan (1981) reports in her study with learning disabled students, that musical/visual and verbal/visual mediational strategies are both superior to either musical or verbal presentation alone in enhancing recall; and (b) the combined mediational mode more nearly approximates normal classroom presentation of material. In addition, the visual presentation more nearly approximates the written response mode used in pretest and posttests (visual presentation consisted of each problem, with and without answers, on white 6" x 8" flash cards).

Preparation of tapes for treatment. The auditory presentation of the multiplication facts was recorded on tape for both verbal and musical treatment conditions in order to assure consistency of presentation and rehearsal. Recordings were made on Maxell C90 tapes, using a SONY TCM-131 recorder with condensor microphone. All spoken and sung input was provided by an adult female with adequate musical skill

to read music and maintain the desired pitch sequences without accompaniment.

All tapes were reviewed by Dr. Dale Bartlett, professor of music at Michigan State University, in order to assure clarity and accuracy. In order to establish that the verbal tapes did, indeed, constitute normal speech, the verbal tapes were reviewed by two speech pathologists: Sherry Martin, M.A., CCC-Sph, teacher of speech and language impaired, Ingham Intermediate School District (Michigan); and Kelly Kidder, supervisor, Speech Pathology Department, Grand Rapids (Michigan) Public Schools. Both experts signed affidavits stating that the tapes consisted of normal adult speech.

Melodic sequences for the nine multiplication problems were self-composed, using pitches C4 through G4. All intervallic movement was by step or arpeggiation (skip of a third) and implied C major tonality. Self-composed tunes were used for the following reasons: (a) to avoid subject familiarity with pre-existent tunes; (b) to limit the pitch range, using the tonic and dominant poles of C major tonality (research supports tonal music as more easily recalled than random or atonal pitch sequences); and (c) finally, self-composed melodies within a restricted pitch range are commonly utilized in psychoacoustic research (Jellison, 1976).

The nine melodic sequences were set alternately to three rhythmic patterns: (a) duple meter with minimal distortion of natural speech rhythms, (b) duple meter with syncopation—a deliberate distortion of natural speech rhythms, and (c) triple compound meter. Each of these rhythmic patterns was used in conjunction with each of the nine melodic patterns on three separate tapes A, B, and C. For example, the

melody accompanying the problem  $8 \times 5 = 40$  was sung to a duple meter with minimal rhythmic distortion on Tape A. On Tape B, the same melody was sung to duple meter with syncopated rhythmic groupings. On Tape C, triple compound meter was used in conjunction with the same melody. (See Appendix C for all melodic-rhythmic patterns.) The combining of the nine melodic sequences with three different rhythmic patterns was to examine any trend toward increased recall due to specific types of melody or rhythm.

In order to avoid primacy/recency effects, the three tapes presented the nine problems in different sequence orders. All tapes initially presented the tables of both seven and eight in ascending order; but following this initial presentation, the problems were presented in an alternate order based on an even or odd sequence (see Appendix B for the order of problem presentation). Both musical and verbal tapes contained the same word content in the same order of presentation.

While the majority of instructions appear on the tapes, the remaining instructions for pretest, treatment, and posttests were written in a standard form to provide greater consistency of testing conditions. These instructions were examined for usability during the pilot study and minimally adjusted for use in the major study. All standardized instructions appear in Appendix E.

Preparation of measurement devices of recall accuracy-pretest and posttests. In order to determine each subject's pretest knowledge and posttest recall accuracy, a device for measuring accurate recall of the memory task was developed. For the pretest and all five

posttests, subject responses were answered on individual  $3\frac{1}{2} \times 3\frac{1}{2}$ " cards containing one of the nine unanswered multiplication problems (found in the treatment memory task) per card. Each problem was presented twice during each pretest and posttest with all 22 cards pretested in a random order.\*

Responses were obtained in the written mode, since that is the mode which is used predominantly in classroom tasks. The range of correct responses was from 0 to 18.

In addition to the two presentations of each problem with the number seven or eight appearing in the top position (ex.  $7 \times 9$  or  $8 \times 9$ ), a third presentation of the problem appeared in reverse order (ex.  $9 \times 7$  or  $9 \times 8$ ) in order to examine the subject's awareness of the commutative principle of multiplication. These additional problems were not included in statistical analysis but rather are discussed in the final chapter as an observational discussion.

Posttest problems were presented individually for the following reasons: (a) to provide control over the amount of time available for each response (five seconds). By providing a flash presentation of one problem at a time, the subject had limited time to rely on computational aids aside from rehearsal recall (such as using fingers or adding). This was particularly important to monitor since the measured outcome is to represent short-term memory recall; (b) to avoid an interaction effect among problems. Since each problem was presented twice, the individual presentation of problems impeded the

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\*A minor exception to random presentation was due to deliberate avoidance of the two most recently rehearsed problems. This was done in order to let the first two posttest problems act as distractors in the manner described by Norman (1976) for short-term memory testing.



subject's ability to look back at earlier responses in order to check later responses; (c) to reduce visual stimuli. Some learning disabled students are easily distracted or become frustrated when presented with a full page of mathematical problems. Thus, by presenting one problem at a time, the student could address full attention only to that response.

In order to tally the number of correct posttest responses (and also to note any unusual response patterns such as digit reversals), scoring sheets were provided for each subject (see Appendix A). The number of accurate pretest and posttest responses provide the dependent variable for the study.

#### Data Collection

Following the development of treatment and testing materials, the collection of research data was conducted in the following elementary schools of the greater Grand Rapids, Michigan, area:

##### East Grand Rapids Public Schools

Wealthy School  
Breton Downs School

##### Forest Hills Public Schools

Ada School  
Collins School  
Orchard View School  
Pine Ridge School  
Thornapple School

##### Godfrey Lee Public Schools

##### Godwin Heights Public Schools

North Godwin  
South Godwin  
West Godwin

Grand Rapids Public Schools  
Beckwith School  
Coit School  
Fountain School  
Hall School  
Ottawa Hills School  
Palmer School

Oakdale Christian School

St. Andrew's Catholic School

Seymore Christian School

Sylvan Christian School

Wyoming Public School  
Oriele Park School  
Taft School

All research procedures were carried out by the author and Denise Joseph-Enders, a certified teacher of the learning disabled. Each of the researchers tested half of the subjects for each treatment condition in order to equate response differences due to testor differences.

Student involvement was subject to the consent of school administrators, classroom and resource room teachers, written consent of parents, and, finally, consent of the student (see parental consent forms in Appendix G). In order to assure subject anonymity, each student was issued an identification number for data collection purposes.

Following parental consent, all potential subjects were screened for I.Q. and current knowledge of the memory task. Following screening, all eligible subjects participated in a total of five treatment sessions, including one session for Experiment I and four additional sessions for Experiment II (see Table 4 for a description of the entire research design).

TABLE 4. EXPERIMENT I AND EXPERIMENT II--THE PROCEDURAL DESIGN

| Group Level       | Pretest        | Session I<br>Exp. I, am | Session II<br>Exp. II, pm     | Session III<br>Exp. II, am    | Session IV<br>Exp. II, pm     | Session V<br>Exp. II, am      |
|-------------------|----------------|-------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| Normal            | T <sub>1</sub> | Verbal T <sub>2</sub>   | X <sub>1</sub> T <sub>3</sub> | X <sub>1</sub> T <sub>4</sub> | X <sub>1</sub> T <sub>5</sub> | X <sub>1</sub> T <sub>6</sub> |
|                   |                |                         | X <sub>2</sub> T <sub>3</sub> | X <sub>2</sub> T <sub>4</sub> | X <sub>2</sub> T <sub>5</sub> | X <sub>2</sub> T <sub>6</sub> |
|                   |                |                         | O <sub>1</sub> T <sub>3</sub> | O <sub>1</sub> T <sub>4</sub> | O <sub>1</sub> T <sub>5</sub> | O <sub>1</sub> T <sub>6</sub> |
|                   | T <sub>1</sub> | Musical T <sub>2</sub>  | X <sub>3</sub> T <sub>3</sub> | X <sub>3</sub> T <sub>4</sub> | X <sub>3</sub> T <sub>5</sub> | X <sub>3</sub> T <sub>6</sub> |
|                   |                |                         | X <sub>4</sub> T <sub>3</sub> | X <sub>4</sub> T <sub>4</sub> | X <sub>4</sub> T <sub>5</sub> | X <sub>4</sub> T <sub>6</sub> |
|                   |                |                         | O <sub>2</sub> T <sub>3</sub> | O <sub>2</sub> T <sub>4</sub> | O <sub>2</sub> T <sub>5</sub> | O <sub>2</sub> T <sub>6</sub> |
| Learning Disabled | T <sub>1</sub> | Verbal T <sub>2</sub>   | X <sub>1</sub> T <sub>3</sub> | X <sub>1</sub> T <sub>4</sub> | X <sub>1</sub> T <sub>5</sub> | X <sub>1</sub> T <sub>6</sub> |
|                   |                |                         | X <sub>2</sub> T <sub>3</sub> | X <sub>2</sub> T <sub>4</sub> | X <sub>2</sub> T <sub>5</sub> | X <sub>2</sub> T <sub>6</sub> |
|                   |                |                         | O <sub>1</sub> T <sub>3</sub> | O <sub>1</sub> T <sub>4</sub> | O <sub>1</sub> T <sub>5</sub> | O <sub>1</sub> T <sub>6</sub> |
|                   | T <sub>1</sub> | Musical T <sub>2</sub>  | X <sub>3</sub> T <sub>3</sub> | X <sub>3</sub> T <sub>4</sub> | X <sub>3</sub> T <sub>5</sub> | X <sub>3</sub> T <sub>6</sub> |
|                   |                |                         | X <sub>4</sub> T <sub>3</sub> | X <sub>4</sub> T <sub>4</sub> | X <sub>4</sub> T <sub>5</sub> | X <sub>4</sub> T <sub>6</sub> |
|                   |                |                         | O <sub>2</sub> T <sub>3</sub> | O <sub>2</sub> T <sub>4</sub> | O <sub>2</sub> T <sub>5</sub> | O <sub>2</sub> T <sub>6</sub> |

Day 1 Day 2 Day 3

T = Pretest and Posttests

X<sub>1</sub> = Verbal/Repetition

X<sub>2</sub> = Verbal/Modeling

X<sub>3</sub> = Musical/Repetition

X<sub>4</sub> = Musical/Modeling

O<sub>2</sub> = Posttest Only/Musical Group

O<sub>1</sub> = Posttest Only/Verbal Group

Experiment I. The purpose of Experiment I was to examine the effect of the two independent variables, group level (normal and learning disabled) and rehearsal mode levels (musical and verbal rehearsal) on the dependent variable, the number of items accurately recalled following a single rehearsal of multiplication facts (see Table 5 for a description of Experiment I).

TABLE 5  
EXPERIMENT I

| <u>Group Level</u>          | <u>Pretest</u> | <u>Session I</u>  | <u>Posttest I</u> |
|-----------------------------|----------------|-------------------|-------------------|
| Learning Disabled    n = 30 | T1             | Musical<br>n = 15 | T2                |
|                             | T1             | Verbal<br>n = 15  | T2                |
| Normal            n = 30    | T1             | Musical<br>n = 15 | T2                |
|                             | T1             | Verbal<br>n = 15  | T2                |

Data collection for Experiment I consisted of a pretest and a posttest score. Subject responses written during the rehearsal session were not included in analysis.

Data were collected in the following manner. First, 15 normal and 15 learning disabled subjects were assigned randomly to either a musical rehearsal mode or the verbal rehearsal mode.

Pretest. In order to establish a baseline of each individual's current knowledge of multiplication facts, a pretest of 22 multiplication problems was administered to the subject, with individual problems presented in random order. The students were allowed five

seconds to provide a written response. In the case of illegible handwriting, the student was asked to verbally confirm the written answer at the close of the pretest. The number of correct responses (not counting commutative problems) were tallied, and those subjects answering 13 or fewer accurate responses (out of 18) were included in the following treatment procedures.\*

Treatment. During the treatment session, each subject was exposed to two rehearsals of each problem through taped presentation of the multiplication facts. One rehearsal consisted of the following sequence: (a) the subject listened to the problem on tape while viewing a flash-card of the problem showing the answer; (b) the subject repeated the problem along with the voice on the tape, still viewing the answered problem; (c) while viewing the problem in unanswered form, the subject was asked to fill in the response to an unanswered problem on the tape (ex.: "Eight times nine is \_\_\_\_."). A two second pause followed to allow time for the written response on a 4" x 4" practice card; (d) after the student responded, the correct answer was made available on a flash-card so that the student could check his accuracy. If the student were incorrect, he was instructed to draw a line through the response and to write the correct response next to it; and, finally, (e) the problem was stated one last time on the tape, and the subject was asked to rehearse (verbally or musically) the problem along with the tape. Each multiplication fact was

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\*The mean scores on the pretest for the two groups were similar, with the learning disabled scoring  $\bar{x} = 3.1333$  and normals  $\bar{x} = 3.333$ . The variances for the two groups' pretests were as follows: learning disabled--11.7747; normal--9.4362. The significant difference in age between the two groups (see Table 3) should be considered in interpreting these pretest results.

presented in the above format two times for Experiment I. The exact order of problem presentation appears in Appendix B. (See Appendices E and F for standardized instructions and tape content.)

Posttesting. Immediately following the treatment, the subject was given a posttest consisting of the same problems as those in the pretest. As in the pretest, the problems were presented in a random order and the subject was given five seconds for a written response. Recall performance was quantified by tallying the number of accurate responses out of the 18 available problems (not including commutative problems).

#### Data Analysis--Experiment I

An analysis of covariance (ANCOVA) employing a 2 x 2 factorial design was selected for analysis of the data from Experiment I. This statistical procedure was chosen for the following reasons: (a) it is less subject to error of measurement from problems such as ceiling effect and regression toward the mean than is the use of gain scores; and (b) this procedure statistically adjusts initial differences between the normals and learning disabled subjects on the pretest achievement, thus increasing the precision of the analysis of variance test.

The number of accurate multiplication problems in pretesting and posttesting acted as the dependent variable, and group level (learning disabled or normal) and rehearsal mode level (musical or verbal) acted as the independent or treatment variables.

The significance level for acceptance or rejection of the null hypothesis was set at  $P \leq .05$ . It was assumed that if the analysis of

data revealed a significant difference in recall accuracy, this difference could be attributed to the independent variables rather than to chance effects.

Experiment II. The purpose of Experiment II was to examine the effect of teaching method and the passage of time as well as group level and rehearsal mode on the dependent variable, the number of accurate recall responses. While the treatment in Experiment I consisted of a single rehearsal of the multiplication problems, Experiment II included four additional treatment sessions carried out over a period of three days (see Appendix B for the testing schedule) in order to examine the effect of the passage of time and extended rehearsal on recall accuracy.

In order to investigate various teaching methods, the initial treatment groups assigned in Experiment I were further subdivided through random assignment in order to test the following methods: (a) posttesting only, (b) repetition only, and (c) repetition with modeling and cuing. Table 6 shows the breakdown of subgroups for Experiment II.

Treatment for Experiment II took place in four sessions on four successive mornings and afternoons (see Table 7 for treatment design). Each specific method variant will be discussed individually, beginning with the posttesting only.

Variant 1--posttesting only. Subjects in this group received no further rehearsal of multiplication facts after the initial rehearsal in Experiment I. Rather, they completed four posttests in the same testing schedule as other treatment groups; i.e., afternoon,

TABLE 6  
BREAKDOWN OF SUBGROUPS--EXPERIMENT II

| <u>Group Membership</u>    | <u>Rehearsal Mode</u> | <u>Teaching Method</u>                                     |
|----------------------------|-----------------------|--|
| Normal (n = 15)            | Verbal rehearsal      | Posttest (n = 5)<br>Repetition (n = 5)<br>Modeling (n = 5) |
| Normal (n = 15)            | Musical rehearsal     | Posttest (n = 5)<br>Repetition (n = 5)<br>Modeling (n = 5) |
| Learning Disabled (n = 15) | Verbal rehearsal      | Posttest (n = 5)<br>Repetition (n = 5)<br>Modeling (n = 5) |
| Learning Disabled (n = 15) | Musical rehearsal     | Posttest (n = 5)<br>Repetition (n = 5)<br>Modeling (n = 5) |

morning, afternoon, morning. All four posttests consisted of the same problems, presented in the same manner as the pretest and posttest I: problems were presented individually in random order and subjects were allowed five seconds to provide a written response.

Variant 1 constituted an experimental control which provided information on changes in recall across time (over four sessions) that were not a direct result of other treatment variables; i.e., rehearsal mode of Method I or II.

Variant 2--method I, repetition. Subjects in this group received four additional rehearsals of the multiplication facts after the initial rehearsal session in Experiment I. The rehearsal method in these four sessions consisted of repetitions of the taped session used in Experiment I. The additional four rehearsals were identical to rehearsal session I of Experiment I with the following exceptions:



TABLE 7  
EXPERIMENT II TREATMENT DESIGN

|                   |                | <u>Session I</u> |                | <u>Session II</u> |                | <u>Session III</u> |                | <u>Session IV</u> |                |
|-------------------|----------------|------------------|----------------|-------------------|----------------|--------------------|----------------|-------------------|----------------|
| LEARNING DISABLED | T <sub>2</sub> | X <sub>1</sub>   | T <sub>3</sub> | X <sub>1</sub>    | T <sub>4</sub> | X <sub>1</sub>     | T <sub>5</sub> | X <sub>1</sub>    | T <sub>6</sub> |
|                   | T <sub>2</sub> | X <sub>2</sub>   | T <sub>3</sub> | X <sub>2</sub>    | T <sub>4</sub> | X <sub>2</sub>     | T <sub>5</sub> | X <sub>2</sub>    | T <sub>6</sub> |
|                   | T <sub>2</sub> | O <sub>1</sub>   | T <sub>3</sub> | O <sub>1</sub>    | T <sub>4</sub> | O <sub>1</sub>     | T <sub>5</sub> | O <sub>1</sub>    | T <sub>6</sub> |
|                   | T <sub>2</sub> | X <sub>3</sub>   | T <sub>3</sub> | X <sub>3</sub>    | T <sub>4</sub> | X <sub>3</sub>     | T <sub>5</sub> | X <sub>3</sub>    | T <sub>6</sub> |
|                   | T <sub>2</sub> | X <sub>4</sub>   | T <sub>3</sub> | X <sub>4</sub>    | T <sub>4</sub> | X <sub>4</sub>     | T <sub>5</sub> | X <sub>4</sub>    | T <sub>6</sub> |
|                   | T <sub>2</sub> | O <sub>2</sub>   | T <sub>3</sub> | O <sub>2</sub>    | T <sub>4</sub> | O <sub>2</sub>     | T <sub>5</sub> | O <sub>2</sub>    | T <sub>6</sub> |
| NORMALS           | T <sub>2</sub> | X <sub>1</sub>   | T <sub>3</sub> | X <sub>1</sub>    | T <sub>4</sub> | X <sub>1</sub>     | T <sub>5</sub> | X <sub>1</sub>    | T <sub>6</sub> |
|                   | T <sub>2</sub> | X <sub>2</sub>   | T <sub>3</sub> | X <sub>2</sub>    | T <sub>4</sub> | X <sub>2</sub>     | T <sub>5</sub> | X <sub>2</sub>    | T <sub>6</sub> |
|                   | T <sub>2</sub> | O <sub>1</sub>   | T <sub>3</sub> | O <sub>1</sub>    | T <sub>4</sub> | O <sub>1</sub>     | T <sub>5</sub> | O <sub>1</sub>    | T <sub>6</sub> |
|                   | T <sub>2</sub> | X <sub>3</sub>   | T <sub>3</sub> | X <sub>3</sub>    | T <sub>4</sub> | X <sub>3</sub>     | T <sub>5</sub> | X <sub>3</sub>    | T <sub>6</sub> |
|                   | T <sub>2</sub> | X <sub>4</sub>   | T <sub>3</sub> | X <sub>4</sub>    | T <sub>4</sub> | X <sub>4</sub>     | T <sub>5</sub> | X <sub>4</sub>    | T <sub>6</sub> |
|                   | T <sub>2</sub> | O <sub>2</sub>   | T <sub>3</sub> | O <sub>2</sub>    | T <sub>4</sub> | O <sub>2</sub>     | T <sub>5</sub> | O <sub>2</sub>    | T <sub>6</sub> |

X<sub>1</sub> = Musical/Repetition

X<sub>2</sub> = Musical/Modeling

X<sub>3</sub> = Verbal/Repetition

X<sub>4</sub> = Verbal/Modeling

O<sub>1</sub> = Posttest Only--Musical Group

O<sub>2</sub> = Posttest Only--Verbal Group

T<sub>2</sub> = Covariate Formed by the  
Pretest and Posttest I  
from Experiment I

T<sub>3-6</sub> = Posttests for  
Experiment II

the order of problem presentation was changed from session to session (see Appendix B for the exact order) in order to avoid primacy/recency effects, and each multiplication fact was rehearsed once instead of twice per rehearsal session.

Following each rehearsal session, the subjects took posttests conducted in the same manner and containing the same problems as the pretest and posttest I: problems were presented individually in random order and subjects allowed five seconds to write their responses.

The purpose of Method I, repetition only, was to examine the effect of extended rehearsal, spaced over time, on recall of memory task. The use of repeated, short rehearsal much more closely approximates normal classroom learning than does a single short-term memory task followed by an immediate recall test. In addition, it provides further information about the impact of repeated exposures on the effectiveness of the two rehearsal strategies. According to Norman (1976), it may take repeated rehearsals and exposures to a mnemonic strategy before the subject is able to use it effectively.

#### Variant 3--method II, repetition with modeling and cuing.

Subjects in this group received four additional rehearsals of the multiplication facts after the initial rehearsal in Experiment I. The procedures for this method were similar to Variant 2, repetition only (Method I) with the following exceptions: subjects from both verbal and musical rehearsal groups were asked to select three of the problems out of the nine they found most difficult to remember. While all other problems were repeated in the usual manner (as they were rehearsed in Session 1, Experiment I), the three selected problems were

rehearsed in a special manner. The tester modeled the use of echoic imagery, asking each subject to think the problem inside his head three times, recalling how the words sounded. For those subjects in the musical presentation group, the melody accompanying the problem was sung on the syllable "la" (by the tester) as the subject subvocalized the problem. Subjects were told to try and associate the words with that specific melodic pattern, much in the manner that they might remember the words from a television commercial in conjunction with the musical jingle which accompanies those words. This procedure was used to encourage the subjects to associate the problem with a specific melodic pattern which could later be utilized during the recall process. In addition, the reinforcement of echoic memory and subvocalization was to guide subjects in the use of inner speech which, according to Meichenbaum, can reduce impulsive cognitive responses (1977).

As in Variants 1 and 2, posttesting consisted of random presentation of the multiplication facts with a five second response time. For those problems which the subject chose to subvocalize during the rehearsal, a retrieval cue was given by the tester before the subject was given the response card. The retrieval cue consisted of the stem portion of the problem (ex.: "Eight times nine is \_\_\_\_."). For verbal rehearsal subjects, the cue consisted of the tester's speaking the cue, since speaking was the manner in which the problem was encoded during rehearsal. For the musical rehearsal subjects, the stem was sung to the melodic sequence used during rehearsal. The subjects then responded by providing a written response on the problem card within the usual five second response time.

The choice of the retrieval cue was an outgrowth of research on memory facilitation: in order for a retrieval cue to work effectively, it must also be present at the time of encoding (during the rehearsal process) (Tulving & Donalson, 1972; Donahoe & Wessells, 1980).

In addition to "triggering" encoded information at the desired time of recall, the retrieval cue was to act as a prompt or a reinforcement to the subject that the rehearsal strategy used during the rehearsal session itself could once again be used at the time of recall as an aid to retrieval.

By comparing the effectiveness of modeling and cuing with musical and verbal rehearsal modes, each mode was examined not only as a rehearsal strategy but also as a retrieval cue. In addition, the effectiveness of a rehearsal strategy could be investigated in view of the manner in which it is taught. According to researchers in learning disabilities (Bauer, 1979; Rathmell, 1978; Reid & Hresko, 1981), a memory strategy must not only be provided to the student; its appropriate use must be taught and reinforced.

#### Data Analysis--Experiment II

A multivariate analysis of covariance (MANCOVA) employing a  $2 \times 2 \times 3$  factorial design was chosen for analysis of the data from Experiment II. This statistical procedure was chosen for the following reasons: (a) it is less subject to error of measurement from problems such as ceiling effect and regressions toward the mean than is the use of increased gains; (b) this statistical procedure adjusts initial differences between the normals and learning disabled subjects on the baseline covariate (pretest and posttests I from Experiment I),

thus increasing the precision of the analysis of variance test; and (c) the use of multivariate analysis in conjunction with repeated measures not only provides multiple observations of each subject (each subject provides his own baseline and recall trend over the repeated measures), but also provides information about trends among the measures:

. . . i.e., differences over time, or differences from one experimental condition to another. Multivariate methods enable us to analyze these trends and differences without the restrictive and often unrealistic assumptions of univariate analysis of variance.<sup>30</sup>

The number of accurate multiplication problems in the covariate and posttests II through V acted as the dependent variables. Rather than statistically analyzing each posttest separately, these variables are treated as a multiple variable with the differences among these dependent variables (posttests II through V) tested by transforming the original four variables into contrasts of interest (Finn & Mattsson, 1978).

The significance level for acceptance or rejection of the null hypothesis was set at  $P \leq .05$ . It was assumed that if the analysis of data revealed a significant difference in recall accuracy, this difference could be attributed to the independent variables rather than to chance effects.

#### Methodological Assumptions

In selecting an analysis of covariance for Experiment I, the following methodological assumptions must be made.

1. The subjects in each subgroup are a random sample from their corresponding populations.

2. The populations of the subgroups are normally distributed.
3. The variance (or within group differences) within the subgroups are homogeneous (equal).
4. The regression coefficient (slope) for the regression lines of the subgroup populations are equal.

The violation of assumptions 1, 2, and 3 create little disturbance of the validity of this test if equal  $n$ 's are used in the subgroups, as is the case in this study. The violation of assumption 4 is somewhat more problematic in the use of ANCOVA. While stringent equality of regression lines is not necessary, the departure should not be too great.

In selecting a multivariate analysis of covariance for Experiment II, the restrictions of equal covariance and variance for all subgroups, necessary in a univariate analysis, are relaxed. Thus, the robustness of the  $F$  test is not violated by possible inequality of covariance or variance within any one or all of the subgroups. In addition, the multivariate analysis controls for possible intercorrelation among the multiple measures in a repeated measure design by viewing the four dependent variables (posttests II through V) "as multiple, intercorrelated responses from the same subject."<sup>31</sup>

### Limitations

The following limitations of this study should be noted:

1. Besides the lack of generalizability to subjects with incomparable characteristics, the inability to generalize the findings to a classroom setting may also

exist due to the 1:1 treatment procedures and artificial environment produced in an experimental design.

2. Because the experimental design used in this study includes repeated measures over time, it is impossible to completely control all variables between sessions.

#### Statement of the Testable Hypotheses

Due to the theoretical premises which underlie hypothesis testing, it is impossible to prove that a test hypothesis is true. Rather, when using inferential statistics, the test hypothesis is stated in the null form, and the statistical results gathered from testing data either reject or fail to reject the null hypothesis. The following hypotheses will be expressed in null form and, when appropriate, in a directional alternate form.

#### The Hypotheses for Experiment I

1. No significant difference will occur in recall accuracy between normal and learning disabled students in all treatment methods at the .05 level of confidence.  
  
Alternate hypothesis: normal students will show significantly greater recall than learning disabled students at the .05 level of confidence in all treatment methods.
2. No significant difference will be found in recall accuracy of all subjects from musical as opposed to verbal rehearsal mode at the .05 level of confidence.

Alternate hypothesis: all subjects will show significantly greater recall at the .05 level of confidence following musical as opposed to verbal rehearsals.

3. No significant difference will be found in recall accuracy due to interaction effects from group level and rehearsal mode at the .05 level of confidence.

### The Hypotheses for Experiment II

1. No significant difference will occur in recall accuracy between normal and learning disabled subjects in either musical or verbal rehearsal groups at the .05 level of confidence.

Alternate hypothesis: normal students will show significantly greater recall accuracy than learning disabled students at the .05 level of confidence in all rehearsal modes.

2. No significant difference will occur in recall accuracy of all subjects due to musical as opposed to verbal rehearsal at the .05 level of confidence.  
Alternate hypothesis: all subjects will show significantly greater recall accuracy at the .05 level of confidence following musical as opposed to verbal rehearsal.

3. No significant difference will occur in recall accuracy of all subjects due to levels of teaching method at the .05 level of confidence.

Alternate hypothesis: all subjects will show



significantly better recall accuracy following repeated rehearsals as opposed to posttesting only, and following repetition with modeling and cuing as opposed to repetition alone.

4. No significant difference will be found in recall accuracy at the .05 level of confidence due to interaction effects from the following combinations across time:
  - a. group level by rehearsal mode level,
  - b. group level by teaching method level,
  - c. rehearsal mode level by teaching method level, and
  - d. group level by rehearsal mode level by teaching method level.

### Summary

In summary, the purpose of this study was to examine the effectiveness of melodic-rhythmic patterns (imposed upon words) as a memory rehearsal strategy to aid retention of multiplication facts for learning disabled and normal students. Because the extent of time spent in rehearsal, as well as the method of teaching a strategy can be as important as the actual choice of that strategy itself, a repeated measures design was selected to examine the effect of repeated rehearsal as well as the effects of modeling and cuing, in conjunction with repeated rehearsal, on recall of a short-term memory task.

Due to the intercorrelation of scores for each subject in a repeated measures design and in order to provide a robust F test despite possible violations of test assumptions, a multivariate analysis

of the data was selected. The results of the analysis appear in the following chapter.

## CHAPTER IV

### FINDINGS

This study examined the effect of musical or verbal rehearsal in conjunction with two teaching methods on the recall of a short-term memory task by learning disabled and normal subjects. The investigation consisted of two experiments conducted over five separate sessions. Each experiment and its findings will be discussed separately, beginning with Experiment I.

#### Experiment I

Experiment I included the following independent variables: group membership level (learning disabled and normal subjects) and rehearsal mode levels (musical or verbal rehearsal). The dependent variable, number of accurate responses in the pretest and posttest, acted as a measure of short-term recall of the treatment memory task--multiplication facts.

During data collection, 60 subjects (30 learning disabled and 30 normal subjects) were assigned within their own group levels to two treatment groups--musical or verbal rehearsal. Subjects were pretested to establish a baseline for current knowledge of the memory task. Treatment consisted of a single rehearsal session of multiplication facts. Immediately following treatment, recall of the memory task was measured through a posttest, which was administered in the same manner as the pretest.

The results were analyzed through an analysis of covariance (ANCOVA) with a 2 x 2 factorial design; computation was performed by a Univariate Analysis of Covariance program written by Jeremy Finn.\* The criterion for statistical significance was set at  $P \leq .05$ . Three separate hypotheses for main and interactive effects were examined. Each hypothesis will be discussed separately, beginning with interactive effects, since the source of any interaction must be accounted for before main effects can be separately and independently examined.

### Interaction Effects

#### Hypothesis I

$H_0$ : No significant differences will be found in recall accuracy due to interaction of group level and rehearsal mode level at the .05 level of confidence.

Because the P value of .2597 was greater than the .05 level of confidence set for acceptance or rejection of the null hypothesis, the null hypothesis was accepted. Results fail to support the significant effect of interaction of group membership and rehearsal mode on recall accuracy. The results appear in Table 8.

Because no interactive effects were found, the main effects of group membership or rehearsal mode could be independently examined.

### Main Effects

The two main effects, group level and rehearsal mode level were tested individually using Finn's Univariate ANCOVA program. A null

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\*Jeremy D. Finn, State University of New York at Buffalo. Multivariate: Univariate and Multivariate Analysis of Variance, Covariance, Regression, and Repeated Measures, Version VI, Release 2, September, 1977, National Educational Resource, Inc.

TABLE 8  
ANCOVA--FINDINGS FOR EXPERIMENT I

| <u>Source</u>      | <u>Degrees of Freedom</u> | <u>Mean Square</u> | <u>F</u> | <u>P</u> |
|--------------------|---------------------------|--------------------|----------|----------|
| Grand mean between | 1                         | 64.4100            | 21.5900  | .0001    |
| Group membership   | 1                         | 19.8058            | 6.6388   | .0127    |
| Rehearsal mode     | 1                         | 12.6196            | 4.2300   | .0445    |
| Group X mode       | 1                         | 3.8696             | 1.2971   | .2597    |
| Error              | 55                        | 2.9832             | ---      | ---      |

hypothesis concerning the main effect of each independent variable is presented individually.

#### Hypothesis II

$H_0$ : No significant difference in recall accuracy will occur between normal and learning disabled students in all treatment methods at .05 level of confidence.

The obtained P value indicates that under the null hypothesis, the probability of having an F value equal to or greater than that calculated is .0127. Since the .05 confidence level was set for acceptance or rejection of the null hypothesis, it was rejected. The findings support the effect of group membership upon recall of a short-term memory task. An examination of the group means for gains between pretest and posttest shows significantly greater recall by normal, as opposed to learning disabled, subjects in both verbal and musical rehearsal modes (see Table 9 for the obtained means of gains).

The main effect for rehearsal mode level is statistically examined in the null Hypothesis III.

TABLE 9

OBTAINED GROUP MEANS DERIVED FROM  
GAINS BETWEEN PRETEST AND POSTTEST

| <u>Group Level</u> | <u>Rehearsal Mode</u> |                  |
|--------------------|-----------------------|------------------|
|                    | <u>Musical</u>        | <u>Verbal</u>    |
| Normal             | $\bar{x} = 1.60$      | $\bar{x} = 3.20$ |
| Learning Disabled  | $\bar{x} = 1.20$      | $\bar{x} = 1.33$ |

### Hypothesis III

$H_0$ : No significant difference in recall accuracy will occur between musical and verbal rehearsal mode at the .05 confidence level.

An examination of the results for rehearsal mode show a P level of .0445, which is smaller than the .05 confidence level. Therefore, the null hypothesis is rejected. It is reasonable to believe that the rehearsal mode significantly influenced recall of the short-term memory task. While there is a significant difference, the direction for improved recall does not support the research, or alternate, hypothesis reported in Chapter III--that musical rehearsal would show significantly greater recall than verbal rehearsal. An examination of group means in Table 9 indicates that those subjects in the verbal subgroup showed greater recall than those subjects in the musical rehearsal subgroup.

In summary, the following statistical findings resulted in Experiment I: the interactive effect of group by rehearsal mode proved

nonsignificant. Both of the main effects, however, resulted in statistically significant differences, with normals showing greater recall than learning disabled subjects, and verbal rehearsal resulting in greater recall than musical rehearsal.

### Experiment II

Experiment II consisted of a repeated measures design in which each subject (the same subjects who took part in Experiment I) participated in four additional exposures to the memory task. In addition to the effects of group level and rehearsal mode examined in Experiment I, the effects of two teaching methods and the passage of time were added as independent variables. The effect of the passage of time was examined through repeated posttests of recall accuracy (the dependent variable) over the four treatment sessions.

In order to collect data for Experiment II, the treatment groups established in Experiment I were further subdivided into subgroups through random assignment into one of the three teaching methods: (a) posttesting only, to provide a control for changes due to the passage of time; (b) repetition of the same verbal or musical rehearsal procedures used in Experiment I over four additional rehearsal sessions; and (c) repetition of rehearsal with added modeling and cuing, in which the subject was coached in the use of the rehearsal strategy as well as provided a retrieval cue during recall. The pretest and posttest scores acted as covariates to the dependent variable, posttest scores from repeated sessions II through V in Experiment II.

The statistical analysis of data from Experiment II was provided through a Finn Multivariate Analysis of Covariance (MANCOVA) in a

2 x 2 x 3 factorial design. A multivariate rather than univariate analysis was selected for two major reasons: (a) to increase the robustness of the F test in relation to underlying assumptions, and (b) to provide for the possible intercorrelations among dependent variables obtained in repeated measures.

First, consider the underlying assumption necessary for a robust F test when using a univariate analysis of repeated measures. The statistical manipulation of the four repeated measures in Experiment II results in a symmetric matrix formation consisting of variates and covariates (see Figure 1). In order for the ANCOVA to provide a valid F ratio, there must be an equality of all variates and covariates within the matrix. A separate matrix is formed for each treatment subgroup, and each separate matrix must meet the requirement for homogeneity of variance and covariance. There is little probability of such equality when dealing with human behavior. Thus, the robustness of the univariate analysis of covariance with repeated measures is easily subject to violation.

$$\Sigma = \begin{array}{c|cccc} & 2 & 3 & 4 & 5 \\ \hline 2 & \sigma_{22}^2 & \sigma_{23} & \sigma_{24} & \sigma_{25} \\ 3 & & \sigma_{33}^2 & \sigma_{34} & \sigma_{35} \\ 4 & & & \sigma_{44}^2 & \sigma_{45} \\ 5 & & & & \sigma_{55}^2 \end{array}$$

2, 3, 4, 5 = posttests II through V  
 $\sigma^2$  = variance  
 $\sigma_{ij}$  = covariance  
 $\Sigma$  = the sum of the variables

Figure 1. Symmetric matrix formed from the repeated measures within Experiment II.



In the selection of a multivariate analysis, however, the requirement for equal variance and covariance of the repeated dependent variables is relaxed, resulting in a more robust F test despite violation of equal variance or covariance.

The second rationale for utilizing a multivariate rather than univariate analysis in a repeated measures design is based on the likelihood of intercorrelation among the four repeated measures in Experiment II. Since the posttests consist of four repeated measures of the same memory task by a single subject, there is likely to be intercorrelation among those measures.\* Therefore, viewing any one of these dependent measures without consideration of their intercorrelation may result in an analysis which reflects structural relationships among dependent variables, rather than explanatory variables inferred from those relationships (Bock, 1975).

Through the use of multivariate analysis, the four repeated measures are calculated using a single probability measure for all measures taken jointly. The four measures are transformed into constant, linear, quadratic, and cubic contrasts which take into account the interrelationship of the four measures and treated as one multivariate dependent variable.

In examining the results of an analysis of covariance, the interaction effects must first be examined for significance. In the case of a significant interaction, the source of interaction must be determined before separate and independent analysis of main effects can

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\*The recall that occurs in the fourth posttest is likely to be related to learning that takes place in the third, second, and first rehearsal session.

be justified. Therefore, discussion of the test hypothesis for Experiment II will begin with the interaction effects.

### Interaction Effects

The following null hypothesis for interaction effects was presented in Chapter III.

#### Hypothesis I

$H_0$ : No significant difference will be found in recall accuracy at the .05 level of confidence due to interaction effects from the following combinations across time:

- a. group level by rehearsal mode level,
- b. group level by teaching method level,
- c. rehearsal mode level by teaching method level,
- and
- d. group level by rehearsal mode level by teaching method level.

First, consider the three way interaction of group by mode by method.

$H_0$ : No significant difference will be found in recall accuracy due to interaction of group level by rehearsal mode level by teaching method level.

The P value of .1905, which is greater than the .05 level of confidence, provides support for accepting the null hypothesis (see Table 10 for results of Experiment II). Therefore, it is reasonable to believe that there is no significant difference in recall due to interaction of group by mode by method across time.

TABLE 10  
MULTIVARIATE ANALYSIS OF COVARIANCE  
EXPERIMENT II\*

| <u>Source</u>      | <u>Degrees of Freedom</u> | <u>F</u>    | <u>P</u> |
|--------------------|---------------------------|-------------|----------|
| Grand mean between | 4, 43                     | 11.2024     | .0001    |
| Group              | 4, 43                     | 2.2812      | .0761    |
| Rehearsal mode     | 4, 43                     | 1.0689      | .3837    |
| Method I + II      | 4, 43                     | 10.2665     | .0001    |
| Method II          | 4, 43                     | 1.9314      | .1225    |
| G x R              | 4, 43                     | 1.1489      | .3467    |
| G x MI + II        | 8, 86                     | 1.6908      | .1123    |
| R x MI             | 4, 43                     | 1.6767      | .1730    |
| R x MII            | 4, 43                     | 9.4932      | .0001    |
| G x R x MI + II    | 8, 86                     | 1.4430      | .1905    |
| Error term         | Variable                  | Mean square |          |
|                    | Constant                  | 38.3916     |          |
|                    | Linear                    | 33.6268     |          |
|                    | Quadratic                 | 11.4446     |          |
|                    | Cubic                     | 37.5979     |          |

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\*Univariate step-downs appear in Appendix H.

The next interaction hypothesis examines the interaction of rehearsal mode by teaching method across time.

$H_0$ : No significant difference will be found in recall accuracy due to interaction of rehearsal mode level

by teaching method level across time at the .05 level of confidence.

To examine specifically where an interaction might occur, this null hypothesis was further broken down to examine the interaction of both rehearsal modes with both teaching methods (Method I = repetition; Method II = repetition with modeling and cuing) (see Table 10).

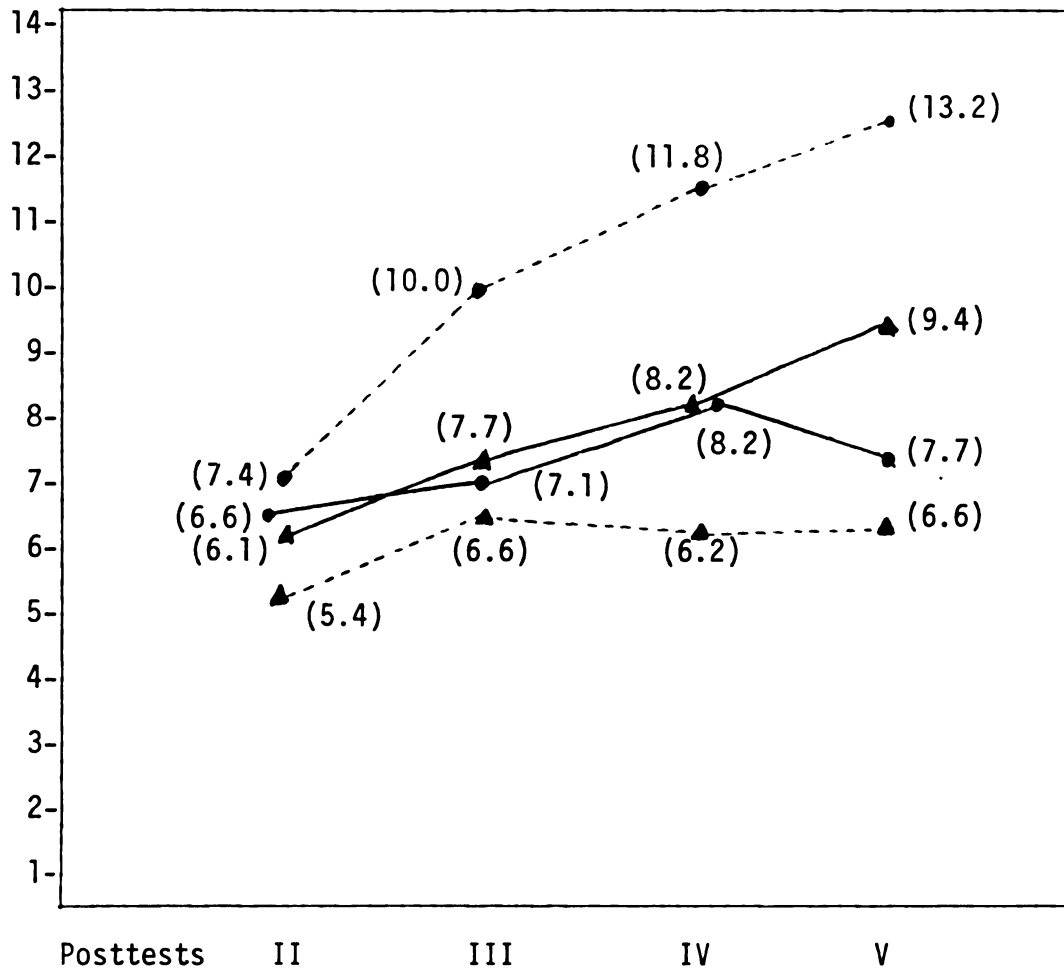
First, consider the interaction effect of rehearsal mode by Method I, repetition. Since the P value of .1730 is greater than the set confidence level, the null hypothesis is accepted. This suggests no significant interaction between rehearsal mode and teaching Method I, repetition.

In contrast, the P value of .0001 for interaction effects of rehearsal mode by Method II, repetition with modeling and cuing, shows a significant influence of this interaction on recall accuracy. Because the P value is smaller than the .05 confidence level, the null hypothesis was rejected. An examination of the group means in Figure 2 reveals that greatest recall resulted from musical rehearsal in conjunction with Method II, repetition with modeling and cuing.

The following hypothesis examines the interaction effect of group by rehearsal mode across time.

$H_0$ : No significant difference will be found in recall accuracy due to interaction of group by teaching method across time at the .05 level of confidence.

The P value of .1123, which is greater than the .05 confidence level, supports the acceptance of the null hypothesis. Therefore, it is reasonable to believe that the interaction of group membership by teaching method did not significantly influence recall.



▲—▲ = Verbal rehearsal--repetition

▲---▲ = Verbal rehearsal--repetition with modeling and cuing

●—● = Musical rehearsal--repetition

●---● = Musical rehearsal--repetition with modeling and cuing

1-14 = Group means for number of accurate posttest responses

Figure 2. Group means--rehearsal mode by teaching method interaction.

One final interaction effect hypothesis examines the interaction of group by rehearsal mode.

$H_0$ : No significant difference will be found in recall accuracy due to interaction of group by rehearsal mode across time at the .05 level of confidence.

The P value, .3467, which is greater than the .05 level of confidence, supports the acceptance of the null hypothesis. The results, therefore, suggest that the interaction of group membership by rehearsal mode across time did not significantly influence recall of the short-term memory task.

Because the hypothesis for the interaction effect of rehearsal mode by teaching method across time was found to be significant, the interpretation of the data analysis related to the main effects of the study becomes problematic.

Interactions complicate the interpretation of comparative studies because they force the investigator to describe differences between particular subclasses rather than the more comprehensive differences associated with the main classes of each way of classification.<sup>28</sup>

According to Popham and Sirotnik (1967), an interaction effect precludes the simple interpretation of single (main) effects of the experimental design.

Because the main effects of rehearsal mode and teaching method appear in a significant interaction effect, these main effects cannot be analyzed in an independent or meaningful manner. Since the group main effect does not appear in a significant interaction effect, however, its significance can be independently tested and interpreted. (The statistical outcome of all main effects appears in Table 10.)

### Main Effects

The null hypothesis for group main effects is as follows:

#### Hypothesis II

$H_0$ : No significant difference will occur in recall accuracy between normal and learning disabled subjects in either musical or verbal rehearsal groups at the .05 level of confidence.

The P value of .0761, which is higher than the set .05 confidence level, supports the acceptance of the null hypothesis. This finding suggests that no difference in recall occurred due to group membership.

Because the main effects of rehearsal mode and teaching method appeared in a significant interaction, Hypotheses III and IV cannot be analyzed in a separate and independent manner. They will, therefore, be reviewed briefly as a unit with the results presented in Table 10. No discussion of findings will be presented for either hypothesis since separate interpretation apart from the interaction effect is not meaningful.

#### Hypothesis III

$H_0$ : No significant difference will occur in recall of all subjects due to musical or verbal rehearsal at the .05 level of confidence (not interpretable).

#### Hypothesis IV

$H_0$ : No significant difference will occur in recall of all subjects due to levels of teaching method at the .05 level of confidence (not interpretable).

### Interpretation

Because Experiments I and II use several different procedures and examine several different research questions, each study will be considered separately in the following discussion of statistical outcomes.

#### Experiment I

Experiment I examined the effect of two rehearsal modes, musical and verbal rehearsal, on the short-term memory of learning disabled and normal subjects. Rehearsal of the memory task, multiplication problems, was limited to one session with two exposures of each multiplication fact. While no interaction of group by rehearsal mode was reported, both main effects, group and rehearsal mode, resulted in statistically significant results: (a) normal students showed significantly greater recall than learning disabled students in both rehearsal modes, and (b) verbal rehearsal resulted in significantly greater recall than musical rehearsal.

While the interaction of group by method was not statistically significant, an examination of group mean gains (Table 9) shows the normal subjects in the verbal rehearsal cell as having clearly the greatest gains in recall. The other three cells--normal/musical, learning disabled/musical, and learning disabled/verbal--show minimal differences (a maximum of .40 difference) among the means for group gain.

While the cell means in Table 9 would suggest a group by rehearsal mode interaction, it is possible that adjustment in pretest scores carried out through the analysis of covariance procedure emphasized



the more subtle difference in gains between the two rehearsal modes of the learning disabled group. One should also consider that the analysis of data using gains is more sensitive to regression toward the mean and ceiling effects, so it may provide less precise information than results gathered through an analysis of covariance procedure.

The significantly greater recall of normal subjects in a short-term memory task is consistent with research findings by Torgesen (1980), Tarver et al. (1976, 1977), and Hallahan et al. (1973, 1974) that normal, academically successful students exhibit more effective short-term memory and spontaneously tend to initiate more effective memory strategies than do learning disabled students. During post-testing, several normal subjects were able to recall as many as five new multiplication problems following a single rehearsal session. In contrast, the learning disabled students tended to recall only one or two and, often, no additional multiplication problems after a single rehearsal session.

The statistically greater recall following verbal, as opposed to musical, rehearsal may reflect what Norman (1976) considers the major drawback of a mnemonic device: in using a mnemonic, the subject must learn the mnemonic device as well as the to-be-remembered information. One single rehearsal session may have provided insufficient opportunity for the subjects to utilize the musical mnemonic in a beneficial manner. The possibility of musical rehearsal acting as an effective mnemonic device in conjunction with more rehearsal time or added reinforcement for its use is examined in Experiment II.

## Experiment II

Experiment II examined the effect of two rehearsal modes (musical and verbal) and two teaching methods (repetition and modeling with cuing) on the short-term memory of learning disabled and normal subjects across time (measured through four repeated posttests). Rehearsal of memory task was repeated over four sessions with post-testing following each session. Statistically significant results were obtained from the interaction of rehearsal mode by teaching method across time. An examination of group means indicated the specific interaction of musical rehearsal by repetition with modeling and cuing (Method II) across time as most influential on increased recall in a short-term memory task (see Figure 2). Because of the occurrence of an interactive effect, main effects for rehearsal mode and teaching method could not be independently and separately interpreted. The main effect of group proved nonsignificant.

The significant influence of the interaction of musical rehearsal mode by repetition with modeling and cuing across time is consistent with findings of Bauer (1979) and Torgesen (1980): while learning disabled students tend not to initiate effective mnemonic strategies spontaneously, with the provision of such strategies along with reinforcement of their use, learning disabled students can show improved short-term recall. The nonsignificant result of group main effect supports this conclusion.

The provision of retrieval cues and the effect of repeated rehearsals over time also deserve careful consideration. While the provision of retrieval cues in the verbal mode did not result in significantly improved recall (in fact, for the learning disabled

students, this mode by method produced the smallest recall gains of all treatment methods), the provision of retrieval cues in the musical rehearsal resulted in significantly greater recall. For example, while only 25% of the responses following verbal cuing were accurate, 83% of the responses following musical cuing were correct. This finding suggests that the melodic patterns introduced during the encoding process act effectively as retrieval cues. The use of normal speech as a cue, as it was used in this experiment, however, is not an appropriate retrieval cue for this particular memory task.

The information provided through repeated measures not only gives more extensive information about learning over time (which is certainly more closely related to actual classroom learning than is a "one-shot" memory test), but also suggest that the effectiveness of a mnemonic device may depend on adequate rehearsal of the device itself. According to Rathmell (1978):

Helping children learn to use new thinking strategies takes time. They may understand a strategy when someone else demonstrates it, but they will need practice before they are able to use it spontaneously as a method of solution.<sup>29</sup>

In summary, the results of this study suggest that while learning disabled students may benefit from mnemonic strategies, the manner in which those strategies are presented may be crucial to their effectiveness: task appropriate mnemonics must not only be provided, but the instructor must model their use and aid the student in practicing the mnemonic until its use becomes a spontaneous action. While learning disabled students appear to need this type of modeling and reinforcement of strategy use since they may fail to automatically comprehend the appropriate use, the improved recall of normal subjects after

the modeling and cuing method indicates that normal students as well might benefit from more extensive teaching of appropriate strategy use.

### Additional Findings

#### Effect of Musical Environment

In addition to the independent variables cited in Experiments I and II, the use of musical rehearsal possibly contributed to recall differences due to variability in subject musical attitude or environment. While not a major hypothesis of the study, the effect of musical environment was examined in conjunction with the level of recall following musical rehearsal.

The primary supposition behind this particular question was the possibility that subjects with more environmental exposure to music, active participation in musical activities, and positive attitude toward music might respond more readily and with better recall to the musical rehearsals than those less musically inclined subjects.

In order to test musical environment as a variable, subjects were given a questionnaire on musical activity participation, musical environment within the home and school, and attitude toward music. The raw scores were categorized into three subgroups: low ( $n = 14$ ), medium ( $n = 15$ ), and high ( $n = 1$ ).<sup>\*</sup> Because the category high musical environment included only one subject ( $n = 1$ ), this category could not be included in statistical analysis by ANOVA; an  $n$  of 1 has inadequate

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<sup>\*</sup>The inclusion of only one subject in the high musical environment category may reflect current cutbacks in school music programs and family investment in musical endeavors during a time of economic problems in the state of Michigan.

variance for the underlying assumptions of ANOVA. Therefore, only the medium and low categories were included in an analysis of variance to determine whether or not musical environment had a significant influence on recall for those subjects in the musical rehearsal treatment condition. The following null hypothesis expresses the supposition.

$H_0$ : No statistically significant difference in recall following musical rehearsal will result from the level of musical environment at the .05 level of confidence.

Table 10 illustrates the statistical findings.

TABLE 11  
MUSICAL ENVIRONMENT AND ITS EFFECTS  
ON RECALL ACCURACY

| <u>Source</u>       | <u>Degrees of Freedom</u> | <u>Mean Square</u> | <u>F</u> | <u>P</u> |
|---------------------|---------------------------|--------------------|----------|----------|
| Musical environment | 1                         | 49.672             | 1.905    | .179     |
| Residual            | 27                        | 26.081             | ---      | ---      |
| Total               | 28                        | 26.924             | ---      | ---      |

The P value of .179 which is higher than the set .05 level of confidence supports the null hypothesis that no significant difference in recall resulted from level of musical environment. It is possible that the generally low musical environment scores contributed to the lack of significant difference for the main effect of rehearsal mode in Experiment I and in the repeated rehearsal method with musical mode interaction in Experiment II.

Further interpretation and discussion of these research findings and their educational implications will appear in Chapter V, Summary and Conclusions.

## CHAPTER V

### SUMMARY AND CONCLUSIONS

#### Summary

The overall purpose of this study was to examine the effectiveness of verbal and musical rehearsal as an aid to retention with learning disabled and normal students. Two experiments were conducted in order to investigate the influence across time of the independent variables--group membership, rehearsal mode, and teaching method--on the dependent variable, the recall of a short-term memory task.

#### Experiment I

In Experiment I, both normal and learning disabled subjects were presented with one verbal or musical rehearsal of multiplication facts followed by a posttest for recall. The purpose of this experiment was to investigate the influence of musical and verbal rehearsal on the recall of normal and learning disabled subjects in a single rehearsal of a short-term memory task.

Statistical analysis revealed that normal subjects showed significantly greater recall than the learning disabled students. In addition, verbal rehearsal resulted in significantly greater recall than the musical rehearsal for both learning disabled and normal subjects.

Several factors may account for the greater recall following verbal rehearsal. First, the musical mnemonic may not be an appropriate strategy for the memory task employed in this study: according to

Donahoe and Wessells (1980), not all memory tasks are responsive to the same mnemonic strategy.

A second explanation may account for the ineffectiveness of the musical rehearsal strategy. While melody or rhythmic structure has been advocated as a mnemonic by several researchers of cognitive processes (Wingfield, 1979; Bower & Bolton, 1969), its use is often recommended in conjunction with a final rhyming syllable at the end of each phrase:

Rhyming is a useful way of connecting unrelated material when sequencing is important . . . . The rhyme not only cues the elements, but any missing item noticeably disrupts the sequence.

If a rhyme is good, a rhyme with a little melody is even better.<sup>32</sup>

In short, the absence of the rhyming component within the melodic-rhythmic strategy may have limited its effectiveness as a memory aid.

While the rhyming aspect and its effect of recall can only be speculated upon within the confines of this study, one final explanation for the ineffectiveness of the musical rehearsal in Experiment I is addressed in Experiment II. This explanation is related to what Norman (1976) points out as the major drawback of mnemonic devices: the mnemonic aid must be learned as well as the to-be-remembered information. In Experiment I, the existence of nine unfamiliar melodies to be learned along with the multiplication facts themselves may have overloaded the memory capacity with too much novel information. In order for the melodic-rhythmic patterns to become adequately assimilated, more exposure or rehearsal may be necessary. This issue will be addressed in the discussion of Experiment II.



In addition to the significant effect of rehearsal mode on recall, the group membership also had a significant impact. The significantly greater recall of normal subjects, as compared with learning disabled subjects, following a single rehearsal of a memory task is not surprising, for researchers in learning disabilities have pinpointed short-term memory difficulties as a problem common to many of these students (Reid & Hresko, 1981; Lerner, 1976; Torgesen, 1980; Bauer, 1979; Hallahan et al., 1974). Further, while normal, academically successful students spontaneously seem to generate their own short-term memory strategies, the learning disabled do not (Hallahan et al., 1974; Tarver et al., 1977).

Certain behavioral characteristics noted in the learning disabled subjects may have also contributed to poorer recall than normal subjects following a single rehearsal. For example, several of the learning disabled subjects were distractible or displayed poor or inconsistent selective attention. Some of these subjects were particularly sensitive to extraneous noises or visual materials within or outside the testing room. One subject (who was reported by the resource room teacher as having difficulties with auditory memory) made numerous remarks during rehearsal about the speech patterns of the voice on the tape recording (ex.: "Did you hear how she just talked faster there? . . . I just heard her sigh . . . now she's slowing down.").

With so much attention devoted to extraneous stimuli, it is very understandable that with only one rehearsal of the memory task, this type of student might easily miss critical information and, in turn, exhibit poor recall.

It should also be noted that the majority of normal students reflected awareness of commutative principles of multiplication and the ability to effectively apply this principle in posttesting. In contrast, only seven of the 30 learning disabled students showed consistent application of commutative principles during posttesting. A few more expressed knowledge of this principle following testing, but did not transfer this knowledge to the posttest task.

Because in this first experiment, the learning disabled performed so poorly in comparison to their normal peers, it appeared that there is need for either greater quantity of rehearsal, or perhaps a different quality of rehearsal. In view of Norman's (1976) comments on the need to learn a mnemonic device adequately, it also seemed beneficial to consider the effect of extended rehearsal on the rehearsal strategies as well. These questions were addressed in Experiment II.

### Experiment II

In Experiment II, both normal and learning disabled subjects were presented with four additional sessions in order to investigate the effect of time and extended rehearsals, in conjunction with rehearsal modes, on recall. In addition, the effectiveness of three methods or variants for presenting the memory task were examined. The results of each method variant, as it interacts with group membership and rehearsal mode, will be discussed individually.

Variant 1--posttesting only. In the first variant in Experiment II, both normal and learning disabled subjects, who had all participated in a single rehearsal during Experiment I, subsequently received no further rehearsal of the memory task; instead, they were given four

posttests over a period of three days. This variant was conducted in order to examine the changes in recall which are the result of the passage of time as opposed to the direct result of rehearsal mode or teaching methods.

In this condition, normal subjects displayed greater retention of the problems rehearsed in Experiment I. In some cases, normal subjects actually improved the number of correct recall items by the fifth posttest. This may be explained by comments volunteered by these subjects: several normal subjects enthusiastically stated, as they returned for posttesting, that they had been practicing their times tables and were ready to take the test again.

In contrast, the learning disabled subjects generally showed poor retention of those items practiced in Experiment I: only one learning disabled subject retained more than two responses from posttest I; more often there was no retention of correct responses at all. While most normal subjects attempted to answer the majority of posttest items, many of the learning disabled students did not even attempt to answer questions of which they were unsure. They would briefly look at the problem and almost immediately turn it over to get ready for the next problem. When the learning disabled subjects did attempt to guess an answer, the guesses often were based on incorrect mathematical reasoning (ex.:  $8 \times 6 = 86$ ,  $8 \times 7 = 87$ ; or  $8 \times 5 = 45$ ,  $8 \times 6 = 46$ , etc.). Rather than initiating their own practice methods outside of the session, as did several normal subjects, the responses of the learning disabled students to posttesting were impulsive answers or comments of frustration.

That the normal students spontaneously tend to generate memory strategies and rehearsal methods, while the learning disabled do not is in keeping with the findings of Hallahan et al. (1974) and Tarver et al. (1977). Without additional rehearsal or guided practice, the learning disabled students failed miserably at the memory task. In contrast, many of the normal students were able to find their own practice strategies, including the initiation of spaced rehearsal of practice sessions outside of the experimental sessions. According to Reid and Hresko (1981), such spaced rehearsal is more effective than one long rehearsal. They also note that learning disabled students may be unaware of the strength of such methods unless they are actually taught to rehearse.

Variant 2--method I--repetition. In the second variant of Experiment II, both normal and learning disabled students were exposed to four additional rehearsal sessions conducted in the same manner as the rehearsal in Experiment I. The purpose of this variant was to examine the effect of more extended, spaced rehearsals on retention.

The results showed that neither the main effects of group membership nor rehearsal mode significantly influenced recall, as was the case in Experiment I (single rehearsal only). While both groups did show increased recall following both rehearsal conditions, the amount of improvement was not statistically significant.

In part the lack of significance in Experiment II may be attributed to the overall limited musical background and interests of the subjects involved in this study: only one subject scored in the high range on the musical environment questionnaire; almost half scored in

the low category. The generally limited musical variable may have reduced the potential effectiveness of the organizational components of music, since these components may not be readily assimilated by a musically naive listener.

Additionally, very few of the subjects were actually able to correctly match each pitch within the melodic patterns, though most subjects showed progressively more accurate approximations of the melodic contour over the five sessions. Subjects generally were able to reproduce rhythmic groupings correctly, however, by the second or third rehearsal.

The actual musical device itself did not appear to have universal appeal for the subjects. Varying spontaneous remarks were made in response to the musical stimuli. Several subjects thought the unaccompanied female singer sounded like an opera singer and added that they like rock music. Several subjects stated that they did not like to sing, which was reflected in their very hesitant participation in rehearsal.

In contrast, a few subjects responded that they thought the tapes were "cool" and that they would like to practice with them again. Several subjects specifically pointed out the melody accompanying 7 x 7 is 49 as their favorite melody.\*

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\*In examining the effectiveness of the nine different melodic and three rhythmic patterns used in the study, the following trends were found (the amount of quantifiable information on melodic or rhythmic recall precluded statistical analysis): none of the three rhythmic patterns, 6/8, 4/4, or 4/4 with syncopation, was clearly superior in enhancing retention. However, the three melodies consisting exclusively of arpeggiated intervals (7 x 6, 7 x 7, and 7 x 9) were superior to verbal rehearsal of these same problems in conjunction with all three rhythmic patterns. This trend suggests the need for further study of retention for specific melodic pattern types.

In short, specific musical preferences, unfamiliarity with the musical style of the tapes or reactions to the taped musical stimuli, in addition to the overall limited musical background and interest of the subjects may have contributed to the lack of significant findings on musical rehearsal strategies.

In addition to the rehearsal mode factor, the group membership factor must also be considered in interpreting the results from variant 2. While the learning disabled subjects showed much poorer recall than normal subjects following the single rehearsal in Experiment I, there was lack of significance due to group membership following the repeated rehearsals.

This outcome supports extended rehearsal as beneficial to the learning disabled subjects, although the increased recall itself was not significant. The mean gains for the learning disabled subjects in the repetition method even appear slightly higher than the scores for normal subjects in this same treatment group. This result may be due in part to the structure of the rehearsal sessions itself. In the repeated rehearsals, even learning disabled subjects with attentional problems responded with increased on-task behavior to the constant prompts and instructions written into the standardized instructions.\*

While this highly structured practice format seemed helpful in keeping learning disabled subjects on task, several of the normal subjects, by the fourth rehearsal, commented that they did not need to use the instructions any more, or wondered if they could practice in a

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\*The standardized instructions were developed specifically to provide adequate structure and prompts to aid those learning disabled students who may have attentional problems.

new way. Several normal subjects peaked in the number of accurate recall items at the fourth posttest and dropped off slightly in the final posttest. It is possible that the same repeated rehearsals may have been overly limited or too redundant to sustain the interest of the normal students. This drop in several test scores of normals in the final posttest may have contributed to the lack of significance for group membership in variant 2.

To summarize the results of variant 2, the exposure to repeated rehearsals resulted in lack of significance due to the effects of group membership and rehearsal mode on recall performance. The amount of increased recall, also, was not statistically significant. Therefore, even though this method seemed to equalize recall performance for the two groups and produced improved performance of the musical rehearsal strategy, the lack of significant recall gains does not support repetition alone as an optimally effective rehearsal format.

Variant 3--method II--repetition with modeling and cuing. In the third variant of Experiment II, both normal and learning disabled subjects participated in four additional rehearsals of the multiplication facts but with the addition of modeling techniques during rehearsal and retrieval cues during recall. The purpose of this variant was to examine whether the manner in which a strategy is taught and the use of retrieval cues can aid retention.

The results showed that both learning disabled and normal students showed significantly greater recall when modeling and cuing was used in conjunction with musical rehearsal. Modeling and cuing in

conjunction with verbal rehearsal, however, did not result in significantly greater recall.

The significant outcome of the musical rehearsal in interaction with modeling and cuing may be explained by educators' claims that not only is it important to provide the learning disabled student with strategies or rehearsal methods, but the appropriate application of the strategy must also be clearly demonstrated and its use reinforced until the student begins to spontaneously initiate its use (Reid & Hresko, 1981; Rathmel, 1978; Keogh & Margolis, 1977; Bauer, 1979). According to Meichenbaum (1977), this modeling and reinforcement can be carried out through first talking through the strategy aloud and then demonstrating its use for the students; second, encouraging overt vocalization of the task at hand; and, third, eventually helping the student to develop inner speech or subvocalization (or reauditorization) as s/he works through the task. Besides helping the student to properly utilize the strategy, this overt and covert vocalization, according to Meichenbaum, also has the advantage of aiding the impulsive student in self-monitoring his/her cognitive responses.

During the modeling procedure used in the third variant, students overtly vocalized the multiplication problems as was done in the second variant (repetition method). In addition, students were encouraged to reauditorize the memory task as well. Then, through cuing, subjects were reinforced to once again reauditorize the task during the recall process.

The subject's response to this procedure might be illustrated by a spontaneous remark made by one of the subjects in this treatment condition. He stated, "When I try to answer the question, I keep



hearing that lady singing inside my head." When asked if that was bothering him, he responded, "No, it helps me to answer the question." In the final posttest, this student was able to answer all but two posttest items correctly. Several other subjects in this treatment condition would respond to the musical cue by singing the remaining portion of the item before writing the response. This type of behavior had not occurred in the musical rehearsal with repetition only. In addition to helping the subject recall the response, this type of approach also seemed to reduce impulsive responses since the subject would try to think the problem through using the strategy before writing the answer or giving up on the problem.

While the provision of cues seemed an important part of the significant influence of musical rehearsal on recall, the same modeling and cuing did not significantly effect recall in the verbal rehearsal mode. For example, while the recall accuracy in response to musical cues was 83%, in contrast only 25% of the responses to verbal cues were answered correctly. It is possible, therefore, that the verbal cues did not provide adequately strong retrieval aids. But why might the musical cue act more effectively?

First, the rhythmic consistency of the musical patterns along with the tonal expectancy may have aided the organization of information, thus providing a more powerful retrieval cue. Second, with the additional attention to the melodic patterns and the reinforcement to associate these melodies with the specific multiplication problems, the melodic pattern may have triggered associations with previously

learned melodic cliches or familiar tunes.\* This is illustrated by a comment by one of the subjects in this treatment condition who remarked that the problem  $8 \times 9 = 72$  was very easy for him to remember because the song that went with the problem reminded him of a song from camp. His responses to this problem in posttesting were consistently correct. Thus, associating this new information with previously learned information seemed to aid recall.

Finally, for those subjects who enjoyed the musical stimuli, the novelty of the musical rehearsal may have aided selective attention and, in turn, recall. Keough and Margolis (1977) emphasize the value of selecting novel or interesting stimuli in presenting important, to-be-remembered information.

In summary, while musical rehearsal, modeling and cuing, or repeated rehearsals did not individually seem to significantly enhance recall, the interaction of all three conditions created a mnemonic with the added strength necessary to effectively aid retention. While the importance of adequately teaching a mnemonic strategy to the learning disabled has been emphasized, the significantly improved recall by the normal population suggests that clear instruction of the mnemonic may be beneficial to normal students as well.

These aforesaid results and interpretations provide a view of overall trends within the normal and learning disabled sample tested. While these findings are important, because of the heterogeneous nature of the learning disabled population, it is important also to

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\*According to Norman (1976) associating new, to-be-learned information with previously learned material is a very effective cognitive organizational aid which aids the retention of the new information.

consider individual student differences which are not reflected by the overall group or subgroup means used in statistical analysis.

In an attempt to examine more individualized learning and behavioral characteristics of the learning disabled population, the sample of 30 subjects was further subdivided, through the aid of information gleaned from the Subject Characteristics Data Sheet, into the following categories: type of learning disability (reading, mathematics, etc.), severity of underachievement in mathematics and other areas of disability, attentional problems (slight or moderate), hyperactivity (yes or no).

Across subgroup categories, recall trends reflected the overall means for various treatment conditions. In other words, these subgroups responded well to the musical rehearsal as it interacted with modeling and cuing over four rehearsals. With one exception, specific subgroups exhibited no unique recall trends in contrast to the overall trends of the learning disabled group means. The only treatment condition in which hyperactivity or moderate, as opposed to slight, attention problems seemed to be problematic was in the posttesting only condition. Those subjects with only slight attentional problems showed somewhat better recall scores than those with more serious attentional difficulties. This suggests that the student with more severe attentional problems, in particular, needs repeated rehearsals with guided practice since s/he may miss important information if it is presented in a single exposure.

While it is possible that different categorization techniques than those used in this study might produce groups with more diverse learning patterns, the subgroups selected for this study did not

exhibit dramatically different responses to the treatment conditions. When considering the educational needs of the learning disabled or normal students, the conscientious educator knows that even subgroup characteristics such as area of academic deficiency may not provide adequate information about the individual student's needs. It is at this point that the teacher must consider that particular student and how s/he responds to particular remedial strategies. For example, in this particular study, one of the subjects showed an unusually positive response to the musical rehearsal strategy. Several personal characteristics about this subject seemed to play a role in the success of this rehearsal strategy. First, the subject enjoyed singing and was able to match clearly the correct pitch and rhythmic sequences used during the rehearsal. The subject was successfully able to re-auditorize the melodic patterns as reflected in his comment that he could hear the songs inside his head. During the interview to obtain a musical environment score, while the subject had not had extensive formal musical training or opportunity to attend concerts (this particular subject was from the low socio-economic strata), he stated that both he and his mother were very active in their church choirs, and he proudly added that his mom was "really good at singing." Therefore, for this particular subject, the musical strategy seemed to fit closely with his personal strengths and preferences. This type of information should be considered before an instructor arbitrarily decides to use a particular remedial strategy for all students.

In summary, the effective use of a musical rehearsal strategy is dependent on the manner in which it is taught and reinforced. While the data from this study show an overall trend of improved retention

in the musical rehearsal mode when used in conjunction with modeling and cuing, the instructor should carefully consider the very specific individual needs and characteristics of each student before arbitrarily using such a device.

### Conclusions

In conclusion, the following statements express the major findings of this study.

1. In a single short-term memory task, normal students showed significantly better recall than learning disabled students in all treatment conditions.
2. In a single short-term memory task, verbal rehearsal resulted in greater recall than did musical rehearsal for both learning disabled and normal students.
3. In repeated rehearsals of the memory task, there was no significant difference in recall due to group membership (learning disabled or normal).
4. In the simple repetition method of repeated rehearsals, neither verbal nor musical rehearsal significantly enhanced recall.
5. While verbal rehearsal in interaction with modeling and cuing did not result in significantly greater recall, the interaction of musical rehearsal with modeling and cuing did show statistically significant improvement in recall.

### Recommendations

Because of the constraints of experimental design, this study had to be limited to the examination of only two rehearsal conditions: melodic-rhythmic and verbal rehearsal. Many additional factors besides melodic and rhythmic structure might influence the effectiveness of music as an aid to retention--for example, familiarity of the musical stimuli or music in conjunction with rhyming syllables.

Further, the effectiveness of a strategy should be considered within a classroom as compared to a clinical one-to-one environment. The need for further investigation of musical stimuli as an aid to learning is only one variable. Subject variables is another area of much needed investigation. For example, in this particular study, the screening requirements for level of mathematical achievement may have eliminated some of the more severely learning disabled students who, due to their levels of severity, have not yet even begun multiplication concepts by the age of 9, 10, or 11. The strategies examined in this study need re-evaluation in view of those students who possess these more severe learning problems.

Finally, because of the individualized needs of the learning disabled, the instructor might consider an informal evaluation on the effectiveness of musical rehearsal for specific students. The true worth of any remedial strategy comes down to one final question: does it help a specific student with a specific academic need?

## FOOTNOTES

## FOOTNOTES

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## APPENDICES

## APPENDIX A

### DATA COLLECTION FORMS

# POSTTEST SCORE SHEET

| ID# _____         | Verb.             | Mel. | Rep. | Post | Mod. | Tape A B C |
|-------------------|-------------------|------|------|------|------|------------|
| Pre I II III IV V | Pre I II III IV V |      |      |      |      |            |
| 8 x 5 _____       | 8 x 5 _____       |      |      |      |      |            |
| 8 x 6 _____       | 8 x 6 _____       |      |      |      |      |            |
| 8 x 7 _____       | 8 x 7 _____       |      |      |      |      |            |
| 8 x 8 _____       | 8 x 8 _____       |      |      |      |      |            |
| 8 x 9 _____       | 8 x 9 _____       |      |      |      |      |            |
| 7 x 6 _____       | 7 x 6 _____       |      |      |      |      |            |
| 7 x 7 _____       | 7 x 7 _____       |      |      |      |      |            |
| 7 x 8 _____       | 7 x 8 _____       |      |      |      |      |            |
| 7 x 9 _____       | 7 x 9 _____       |      |      |      |      |            |

Commutative problems:

6 x 8 \_\_\_\_\_

9 x 8 \_\_\_\_\_

6 x 7 \_\_\_\_\_

9 x 7 \_\_\_\_\_

Additional comments:

## SUBJECT CHARACTERISTICS CHECKLIST

ID# \_\_\_\_\_ Parental Consent Form \_\_\_\_\_

Parental Occupation: Father \_\_\_\_\_ Mother \_\_\_\_\_

Birthdate: Year 19 Month \_\_\_\_\_ Day \_\_\_\_\_

\_\_\_\_\_ Previous classroom exposure to multiplication concepts and times tables.

\_\_\_\_\_ No official documentation of emotional, physical, sensory or mental impairment (or learning disabilities for normal subjects).

Grade: 3rd 4th 5th School System \_\_\_\_\_

Public School \_\_\_\_\_ Private School \_\_\_\_\_

Race/ethnicity \_\_\_\_\_

Bilingual? Yes \_\_\_\_\_ No \_\_\_\_\_

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Learning Disabled Students Only

Academic Problem Area: Reading \_\_\_\_\_ Math \_\_\_\_\_ Written Language \_\_\_\_\_

Other \_\_\_\_\_

Resource Room \_\_\_\_\_ Self-contained Room \_\_\_\_\_

Severity of underachievement in all problem areas except math:

---

Math Achievement: Above Grade Level \_\_\_\_\_ Grade Level \_\_\_\_\_

Less Than One Year Below \_\_\_\_\_ 1.0-1.5 Years Below \_\_\_\_\_

2.0-2.5 Years Below \_\_\_\_\_ More Than 2.5 Years Below \_\_\_\_\_

Characteristics: Hyperactive \_\_\_\_\_ Hypoactive \_\_\_\_\_ Neither \_\_\_\_\_

Attention Problems: None \_\_\_\_\_ Slight \_\_\_\_\_ Moderate \_\_\_\_\_ Severe \_\_\_\_\_

L.D. with Minimal Behavioral/Emotional Problems \_\_\_\_\_

L.D. with Secondary Behavioral/Emotional Problems \_\_\_\_\_

L.D. with Severe Behavioral/Emotional Problems \_\_\_\_\_

## EXPERIMENTAL DATA COLLECTION FORM

ID# \_\_\_\_\_ SIT Score (90-120) \_\_\_\_\_ Musical Environment Score \_\_\_\_\_

SEI: Upper Upper Middle Middle Lower Middle Lower

Pretest Score (13 or Lower) \_\_\_\_\_ Pretest Commutative Score \_\_\_\_\_

Group Assignment: Normal \_\_\_\_\_ Verbal \_\_\_\_\_ Posttest Only \_\_\_\_\_

L.D. \_\_\_\_\_ Musical \_\_\_\_\_ Repetition \_\_\_\_\_ Modeling \_\_\_\_\_

Experiment I

Session Date \_\_\_\_\_ Time \_\_\_\_\_

Posttest I Score \_\_\_\_\_ Commutative Score \_\_\_\_\_

Experiment II

Session I Date \_\_\_\_\_ Time \_\_\_\_\_

Posttest II Score \_\_\_\_\_

Session II Date \_\_\_\_\_ Time \_\_\_\_\_

Posttest III Score \_\_\_\_\_

Session III Date \_\_\_\_\_ Time \_\_\_\_\_

Posttest IV Score \_\_\_\_\_

Session IV Date \_\_\_\_\_ Time \_\_\_\_\_

Posttest V Score \_\_\_\_\_

Communtative Score \_\_\_\_\_

Comments:

## APPENDIX B

### TESTING SCHEDULE AND PROBLEM ORDER



## TESTING SCHEDULE AND PROBLEM ORDER

### Session I - Day 1, a.m.

#### Tape A

|       |    |
|-------|----|
| 8 x 5 | 1A |
| 8 x 6 |    |
| 8 x 7 |    |
| 8 x 8 |    |
| 8 x 9 |    |
| 7 x 6 |    |
| 7 x 7 |    |
| 7 x 8 |    |
| 7 x 9 |    |

|       |    |
|-------|----|
| 8 x 6 | 2A |
| 8 x 8 |    |
| 7 x 6 |    |
| 7 x 8 |    |
| 8 x 5 |    |
| 8 x 7 |    |
| 8 x 9 |    |
| 7 x 7 |    |
| 7 x 9 |    |

#### Tape B

|       |    |
|-------|----|
| 8 x 5 | 1B |
| 8 x 6 |    |
| 8 x 7 |    |
| 8 x 8 |    |
| 8 x 9 |    |
| 7 x 6 |    |
| 7 x 7 |    |
| 7 x 8 |    |
| 7 x 9 |    |

|       |    |
|-------|----|
| 8 x 5 | 2B |
| 8 x 7 |    |
| 8 x 9 |    |
| 7 x 7 |    |
| 7 x 9 |    |
| 8 x 6 |    |
| 8 x 8 |    |
| 7 x 6 |    |
| 7 x 8 |    |

#### Tape C

|       |    |
|-------|----|
| 8 x 5 | 1C |
| 8 x 6 |    |
| 8 x 7 |    |
| 8 x 8 |    |
| 8 x 9 |    |
| 7 x 6 |    |
| 7 x 7 |    |
| 7 x 8 |    |
| 7 x 9 |    |

|       |    |
|-------|----|
| 8 x 5 | 2C |
| 7 x 9 |    |
| 8 x 6 |    |
| 7 x 8 |    |
| 8 x 7 |    |
| 7 x 7 |    |
| 8 x 8 |    |
| 7 x 6 |    |
| 8 x 9 |    |

### Session II - Day 1, p.m.

#### Tape A

Sequence 1A

#### Tape B

Sequence 1B

#### Tape C

Sequence 1C

### Session III - Day 2, a.m.

#### Tape A

Sequence 2A

#### Tape B

Sequence 2B

#### Tape C

Sequence 2C

### Session IV - Day 2, p.m.

#### Tape A

Sequence 1A

#### Tape B

Sequence 1B

#### Tape C

Sequence 1C

Session V - Day 3, a.m.

Tape A

Sequence 2A

Tape B

Sequence 2B

Tape C

Sequence 2C

## APPENDIX C

### MELODIC-RHYTHMIC PATTERNS

# MELODIC-RHYTHMIC PATTERNS

## TAPE A



8 x 5 is 40

8 x 6 is 48



8 x 7 is 56

8 x 8 is 64



8 x 9 is 72

7 x 6 is 42



7 x 7 is 49

7 x 8 is 56



7 x 9 is 63

## MELODIC-RHYTHMIC PATTERNS

## TAPE B

8 x 5 is 40      8 x 6 is 48

This block contains two musical phrases. The first phrase is in 4/4 time and consists of a half note G4, a quarter note A4, a quarter note B4, a quarter rest, a half note C5, and a quarter rest. The second phrase is in 6/8 time and consists of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a quarter note E5.

8 x 7 is 56      8 x 8 is 64

This block contains two musical phrases. The first phrase is in 4/4 time and consists of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a half rest. The second phrase is in 4/4 time and consists of a half note G4, a quarter note A4, a quarter note B4, a quarter rest, a half note C5, and a quarter rest.

8 x 9 is 72      7 x 6 is 42

This block contains two musical phrases. The first phrase is in 6/8 time and consists of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a quarter note E5. The second phrase is in 4/4 time and consists of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a half rest.

7 x 7 is 49      7 x 8 is 56

This block contains two musical phrases. The first phrase is in 4/4 time and consists of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a quarter rest. The second phrase is in 6/8 time and consists of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a quarter note E5.

7 x 9 is 63

This block contains a single musical phrase in 4/4 time, consisting of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a half rest.

## MELODIC-RHYTHMIC PATTERNS

## TAPE C

8 x 5 is 40      8 x 6 is 48

The first staff shows two musical phrases. The first phrase is in 6/8 time, consisting of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, and a dotted quarter note D5. The second phrase is in 4/4 time, consisting of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a half note E5.

8 x 7 is 56      8 x 8 is 64

The second staff shows two musical phrases. The first phrase is in 4/4 time, consisting of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a half note E5. The second phrase is in 6/8 time, consisting of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a dotted quarter note E5.

8 x 9 is 72      7 x 6 is 42

The third staff shows two musical phrases. The first phrase is in 4/4 time, consisting of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a half note E5. The second phrase is in 4/4 time, consisting of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a half note E5.

7 x 7 is 49      7 x 8 is 56

The fourth staff shows two musical phrases. The first phrase is in 6/8 time, consisting of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a dotted quarter note E5. The second phrase is in 4/4 time, consisting of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a half note E5.

7 x 9 is 63

The fifth staff shows a single musical phrase in 4/4 time, consisting of a half note G4, a quarter note A4, a quarter note B4, a quarter note C5, a quarter note D5, and a half note E5.

## APPENDIX D

### MUSICAL ENVIRONMENT QUESTIONNAIRE

## MUSICAL ENVIRONMENT QUESTIONNAIRE

ID# \_\_\_\_\_

1. Have you ever played a musical instrument? No \_\_\_\_\_ Yes \_\_\_\_\_  
If so, what? \_\_\_\_\_ How long? Less than 1 year? \_\_\_\_\_  
1-2 Years? \_\_\_\_\_ Over 2 years? \_\_\_\_\_ (If student plays several  
instruments, combine total time.)
2. (if yes to item 1) Does anyone else at home (grandparent, parent,  
brother, sister) play an instrument? No \_\_\_\_\_ Yes \_\_\_\_\_  
Who? \_\_\_\_\_ (record the number)
3. Do you now play or have you ever played in a band or orchestra?  
No \_\_\_\_\_ Yes \_\_\_\_\_  
Do you now sing or have you ever sung in a choir? No \_\_\_\_\_ Yes \_\_\_\_\_
4. Has anyone (else) in your family played in a band or orchestra?  
No \_\_\_\_\_ Yes \_\_\_\_\_ Have s/he sung in a choir? No \_\_\_\_\_ Yes \_\_\_\_\_
5. Do you ever go to concerts or musical programs? Never \_\_\_\_\_  
A few times \_\_\_\_\_ Often \_\_\_\_\_
6. Do you listen to music on the radio or record player? Never \_\_\_\_\_  
Sometimes \_\_\_\_\_ Often \_\_\_\_\_
7. I like to listen to music: A lot \_\_\_\_\_ Sometimes \_\_\_\_\_ Never \_\_\_\_\_
8. I like to sing: A lot \_\_\_\_\_ Sometimes \_\_\_\_\_ Not at all \_\_\_\_\_
9. I like to (or would like to ) play an instrument: A lot \_\_\_\_\_  
Sometimes \_\_\_\_\_ Not at all \_\_\_\_\_
10. Making music or listening to music is fun. Yes \_\_\_\_\_  
Sometimes \_\_\_\_\_ No \_\_\_\_\_



MUSICAL ENVIRONMENT QUESTIONNAIRE  
SCORING SHEET AND POINT DISTRIBUTION

- |                                  |  |           |
|----------------------------------|--|-----------|
| 1. No = 0                        | Yes: less than 1 year = 1<br>1-2 years = 2<br>over 2 years = 3 |           |
| 2. No = 0                        | Yes = 1 point per family member<br>up to maximum of 3 points   |           |
| 3. Band: No = 0<br>Choir: No = 0 | Yes = 1<br>Yes = 1   |           |
| 4. Band: No = 0<br>Choir: No = 0 | Yes = 1<br>Yes = 1   |           |
| 5. Never = 0                     | A few times = 1  | Often = 2 |
| 6. Never = 0                     | Sometimes = 1  | Often = 2 |
| 7. Never = 0                     | Sometimes = 1  | A lot = 2 |
| 8. Not at all = 0                | Sometimes = 1  | A lot = 2 |
| 9. Not at all = 0                | Sometimes = 1  | A lot = 2 |
| 10. No = 0                       | Sometimes = 1  | Yes = 2   |

Total possible points = 22

## APPENDIX E

### STANDARDIZED INSTRUCTIONS

## PRETEST INSTRUCTIONS

T = TESTOR

S = SUBJECT

T: I am trying to find out how best to help students like you to learn their multiplication tables . . . you know, like  $5 \times 2$  is 10 or  $4 \times 6 = 24$ . You have been chosen to help me. What am I trying to find out?

S: (response)

T: That's right (or "Remember"), how students best learn multiplication tables. First, I want to find out how much you already know about multiplying numbers so that I know better what we need to learn. To help me find out, you will do some problems for me. When I give you the problems, I want you to think about the answer and then write it down. You will have a short time to do this before I say, "Stop." How do you answer the question?

S: (response)

T: That's right (or "Remember"). Turn your problem over and get ready to try the next problem. Let's try an example so you can see how much time you have to answer each problem.

(T hands out each card to the student. After five seconds elapse, T says "Stop," and the student turns the card over. T takes back answered card and replaces it with one more example card. Following five seconds, T says:)

Stop. That's about how much time you will have to do each problem. Some of these are harder than others, so I don't expect you to know every answer. Just do the best you can. We will now begin.

(T administers the remainder of the cards. If any digits are illegible, the student will be asked to verbally confirm the answer he has written. When all of the problems are finished, check to see how many problems with the number 7 or 8 in the top position have been answered correctly. Any student completing 13 or fewer problems correctly will be included in Experiment I and II. Thank those students who have completed more than 13 problems correctly, explaining that they will not return for any more sessions. Explain to subjects included in the remainder of the study that they will be practicing their multiplication tables four more times in the next three days. Proceed to Experiment I.)

## INSTRUCTIONS FOR SESSION I

T: Did you notice that many of the problems you tried included the numbers 7 and 8? Since some of the answers were left blank or answered incorrectly, let's see if we can learn to multiply better, practicing the tables of 7 and 8. We are going to practice them in a way that might be a little different from how you do it in class. After we get through practicing, then we will see if this way has helped you to remember how to multiply by 7 or 8.

We're going to practice our tables along with this tape. The person on the tape will tell you how we'll do this, so listen carefully.

CLICK TAPE ON

TAPE: I will say (sing) each multiplication problem four times.  
When I say it the first time, I want you to listen carefully and look at the card which shows those numbers.

(T HOLDS UP EXAMPLE CARD)

Now listen:  $8 \times 5$  is 40.

CLICK TAPE OFF

T: What do we do first?

S: (response)

T: We look at the card and listen.

CLICK TAPE ON

TAPE: The second time I will say "now, repeat," and I want you to say (sing) it back to me. "Now, repeat:  $8 \times 5$  is 40."

CLICK TAPE OFF

T: What do we do the second time?

S: (response)

T: We repeat it.

CLICK TAPE ON

TAPE: The third time, I will say (sing)  $8 \times 5$  is \_\_\_\_\_, but I will leave out the answer. There will be a short pause in the tape. Think the answer to yourself, just as we practiced it. (T

PLACES PRACTICE CARD IN FRONT OF THE SUBJECT.) Then fill in your answer on the card in front of you. Let's try that now. Listen and then write the answer.  $8 \times 5$  is \_\_\_\_.

CLICK TAPE OFF

T: What do you do after she says, " $8 \times 5$  is \_\_\_\_"?

S: (response)

T: Fill in the answer on your answer sheet (as you just did). After you have filled in the answer, I will hold up a card with the correct answer. Check your answer. If it is wrong, write the correct answer beside it. How do you check your answer?

S: (response)

T: Look at the card; and if your answer is not correct, write the correct answer beside it. The person on the tape will repeat the problem one more time. Let's listen as she tells us what to do.

CLICK TAPE ON

TAPE: After we check our answers, we will say (sing) the problem one more time. When I say, "Repeat with me," I want you to repeat the answer back to me. Repeat with me:  $8 \times 5$  is 40.

CLICK TAPE OFF

T: Now that we know what to do, let's try to practice some problems together.

CLICK TAPE ON

TAPE: Listen:  $8 \times 6$  is 48. Now repeat.  $8 \times 6$  is 48. Listen and answer.  $8 \times 6$  is \_\_\_\_\_. (two second pause) Now check your answer. (two second pause) Repeat with me:  $8 \times 6$  is 48. Now, let's go to the next number.

(All the problems will be presented twice. Following the entire tape presentation, proceed with posttesting.)

## POSTTEST INSTRUCTIONS

T: Now let's see if practicing these problems has helped you remember them any better. I'm going to give you another set of multiplication problems. When I give you the problem, think the answer to yourself--just like we practiced them. Then write the numbers in the problem and in the answer, just like before. What do you do?

S: (response)

T: Yes (or "Remember"), first copy the numbers in the problem, and then write the answer. If you are positive that you don't know the answer, just leave it blank. When I say "stop," turn your problem over, and get ready for the next one. What do you do when I say "stop"?

S: (response)

T: Yes (or "Remember"), turn your problem over and get ready to try the next problem. I don't expect you to know every answer. Just do the best you can. We will now begin.

(Administer cards in the same manner as in the pretest. If you suspect digit reversal or a similar problem, after the test has been administered ask those specific problems verbally to check accuracy of the responses in the verbal mode. Note any unusual responses that occur during testing on the comment area of the Posttest Data Form.)

INSTRUCTIONS FOR MUSICAL REHEARSAL  
WITH MODELING AND CUING

T: Do you remember when we practiced our tables of 7s and 8s by singing them? Maybe you wonder why we sang them. Have you ever noticed how some commercials on TV or radio have catchy songs with them . . . like the McDonald's commercial, for example? Well, they use those songs to help you remember their hamburgers. In a similar way, we're singing the multiplication tables to see if singing the problems with songs can help you remember your multiplication tables easier. Why are we singing them?

S: (response)

T: Can you think of three of the tables of 7 or 8 that we practiced before that are really hard to remember? (Review the options, if necessary.)

STUDENT CHOOSES THREE FACTS TO CONCENTRATE ON.

T: OK. What do you do now if you can't remember the answer to a really hard problem? Do you (count on your fingers, guess, give up, etc.)?

S: (response)

T: Well, this time, when we practice the tables, we'll practice all the problems like we did before, except the special problems that you chose. When we get to those problems, we'll pay special attention the song that goes along with those special problems. Later, when you try to answer that problem, maybe remembering the song that goes along with the problem will help you to remember the answer. Let's begin.

(Proceed with the problems on the tape as usual, except those specially chosen problems. When one of those problems comes up, have the students listen and repeat the problem. Then have the student subvocalize or think the problem in his head, three times through. As he does this, sing the melody on the syllable "LA" three times through, telling the student that you would like him to try to remember the melody along with the words. Then continue with the other problems as usual.)

INSTRUCTIONS FOR VERBAL REHEARSAL  
WITH MODELING AND CUING

T: Can you think of three of the tables of 7 or 8 that we practiced before that are really hard to remember? (Review the options, if necessary.)

STUDENT CHOOSES THREE FACTS TO CONCENTRATE ON.

T: OK. What do you do now if you can't remember the answer to a really hard problem? Do you (count on your fingers, guess, give up, etc.)?

S: (response)

T: Well, this time, when we practice the tables, we'll practice all the problems like we did before, except the special problems that you chose. When we get to those problems, we'll pay special attention to the sound of the words that go with those special problems. Later, when you try to answer that problem, maybe thinking about the sound of those words will help you to remember the answer. Let's begin.

(Proceed with the problems on the tape as usual, except those specially chosen problems. When one of those problems comes up, have the student listen and repeat the problem. Then have the student subvocalize or think the problem in his head, three times through. As he does this, tell him to try to remember the sound of the words inside his head. Then continue with the other problems as usual.)



INSTRUCTIONS FOR POSTTEST MUSICAL AND  
VERBAL REHEARSAL WITH MODELING AND CUING

Proceed with the posttesting in the same manner as with Posttest I. When one of the three problems that the student has chosen comes up, as you hand the answer card, either sing (for musical rehearsal group members) or speak (for verbal rehearsal members) the stem of the problem. For example, speak or sing "8 x 5 is \_\_\_\_\_," leaving off the answer. This is to provide a cue consisting of a portion of the initial rehearsal method as it was practiced during rehearsal sessions.

INSTRUCTIONS FOR POSTTESTS FOR  
REPETITION METHOD  
SESSIONS 2 THROUGH 5

T: Remember how we practiced our multiplication tables this morning? Now we're going to see if we can get even better at those tables by practicing four more times in the next few days. We will practice with the tape just like we did before. Let's begin.

(For sessions 2 and 4, begin the tape at sequence 1; and for sessions 3 and 5, begin the tape at sequence 2, as indicated in Appendix B. Do not play the instructions at the beginning of the tape. Begin with the problems. Following each rehearsal, administer a posttest in the same manner as in posttest I.)

---

INSTRUCTIONS FOR POSTTEST ONLY METHOD  
SESSIONS 2 THROUGH 5

T: Remember how we practiced our multiplication tables for 7 and 8? We're going to see if you still remember any of the answers since we last practiced. When I give you the problem, think the answer to yourself--just like we practiced them. Then write the numbers in the problem and the answer, just like before. What do you do?

S: (response)

T: Yes (or "Remember"), first write the numbers in the problem and then write the answer. If you are positive that you don't know the answer, just leave it blank. When I say "stop," turn your problem over and get ready to try another one. What do you do when I say "stop"?

S: (response)

T: (Reply to above response). Turn your problem over and get ready to try the next problem. I don't expect you to know every answer. Just do the best you can. We will now begin.

(Administer cards in the same manner as in the pretest. If any cards are answered illegibly, have the student verbally confirm his answer. Note unusual responses on the comment sheet.)

## APPENDIX F

### TAPE SCRIPT

## TAPE SCRIPT

I will say each multiplication problem four times. When I say it the first time, I want you to listen carefully and look at the card which shows those numbers. (Pause one second.)

Now listen:  $8 \times 5$  is 40. (Two second pause.) The second time I will say, "Now, repeat," and I want you to say it back to me. "Now, repeat" ( $8 \times 5$  is 40). (Two second pause.)

The third time, I will say, " $8 \times 5$  is \_\_\_\_\_," but I will leave out the answer. There will be a short pause in the tape. Think the answer to yourself, just as we practiced it. Then fill in your answer on the answer sheet in front of you. Let's try that now. "Listen and answer:  $8 \times 5$  is \_\_\_\_\_." (Two second pause.)

After we check our answers, we will say the problem one more time. When I say, "Repeat with me," I want you to repeat the answer with me. "Repeat with me:  $8 \times 5$  is 40."

(Two second pause.)

Listen:  $8 \times 6$  is 48. Now repeat.  $8 \times 6$  is 48. Listen and answer,  $8 \times 6$  is \_\_\_\_\_. (Two second pause.) Now check your answer. (Two second pause.) Repeat with me:  $8 \times 6$  is 48. Now let's go to the next number.

(Two second pause.)

Listen:  $8 \times 7$  is 56. Now repeat:  $8 \times 7$  is 56. Listen and answer,  $8 \times 7$  is \_\_\_\_\_. (Two second pause.) Now check your answer. (Two second pause.) Repeat with me:  $8 \times 7$  is 56. Now let's go to the next number.

(Two second pause.)

Listen:  $8 \times 8$  is 64. Now repeat:  $8 \times 8$  is 64. Listen and answer,  $8 \times 8$  is \_\_\_\_\_. (Two second pause.) Now check your answer. (Two second pause.) Repeat with me:  $8 \times 8$  is 64. Now let's go to the next number.

(Two second pause.)

Listen:  $8 \times 9$  is 72. Now repeat:  $8 \times 9$  is 72. Listen and answer,  $8 \times 9$  is \_\_\_\_\_. (Two second pause.) Now check your answer. (Two second pause.) Repeat with me:  $8 \times 9$  is 72. Now let's go to the next problem.

(Two second pause.)

Listen:  $7 \times 6$  is 42. Now repeat:  $7 \times 6$  is 42. Listen and answer,  $7 \times 6$  is \_\_\_\_\_. (Two second pause.) Now check your answer. (Two second pause.) Repeat with me:  $7 \times 6$  is 42. Now let's go to the next number.

(Two second pause.)

Listen:  $7 \times 7$  is 49. Now repeat:  $7 \times 7$  is 49. Listen and answer,  $7 \times 7$  is \_\_\_\_\_. (Two second pause.) Now check your answer. (Two second pause.) Repeat with me:  $7 \times 7$  is 49. Now let's go to the next number.

(Two second pause.)

Listen:  $7 \times 8$  is 56. Now repeat:  $7 \times 8$  is 56. Listen and answer,  $7 \times 8$  is \_\_\_\_\_. (Two second pause.) Now check your answer. (Two second pause.) Repeat with me:  $7 \times 8$  is 56. Now let's go to the next number.

(Two second pause.)

Listen:  $7 \times 9$  is 63. Now repeat:  $7 \times 9$  is 63. Listen and answer,  $7 \times 9$  is \_\_\_\_\_. (Two second pause.) Now check your answer. (Two second pause.) Repeat with me:  $7 \times 9$  is 63.

(One second pause.)

Now that we've practiced these multiplication problems one time through, we're going to practice them a little bit differently by mixing up the order of the numbers. But we'll practice each number the same way that we did before.

At this point, the tape proceeds with Sequence 2 of Tape A, B, or C. Each number is practiced in the same manner, but the sequence of problems is arranged as they appear in Appendix B.

This script constitutes the word content for both verbal and musical rehearsal modes. During the musical tapes, the actual multiplication problems are sung to specific melodic and rhythmic patterns.

## APPENDIX G

### PARENTAL CONSENT FORMS

## PARENTAL CONSENT LETTER

Dear Parent,

I am writing to ask permission for your child to take part in a mathematics project. This project compares several ways to practice multiplication tables, including a musical method. It has been approved by your child's teacher and the Director of Special Education and is supervised by Drs. Dale Bartlett and Linda Patriarca of Michigan State University.

Your child will be asked to take part in five short practice sessions of math facts and one test of verbal skills. If the student is in a special education program, the type of learning problem will be noted by the teacher. Since all information will be recorded using ID numbers, your child's test scores will remain anonymous.

If you agree to have your child in this study, I would appreciate your signing the following consent form and mailing it to the teacher in the enclosed stamped envelope. Since you may have some questions about this study, I will try to contact you by phone in the next few days to discuss it with you.

Sincerely,

Kay E. Gfeller  
Doctoral Candidate in  
Music Education/Therapy

Dr. Linda Patriarca  
Assistant Professor  
Department of  
Special Education

Dr. Dale Bartlett  
Professor and Assistant Chair  
Department of Music

KEG/bar

## CONSENT FORM

I freely consent to have my child take part in a study being conducted by Kay E. Gfeller, under the supervision of Drs. Dale Bartlett and Linda Patriarca of Michigan State University.

1. I understand the nature of my child's participation in this study, as well as the general intent of the study.
2. I understand that my child is free to discontinue participation in the study at any time; that option will be explained to all subjects.
3. I understand that the results of the study and any scores or information used during the study will be treated in strict confidence and that my child and individual test results will remain anonymous. Within these restrictions, results of the study will be made available to me at my request.
4. I understand that my child's participation in the study does not guarantee any beneficial results.
5. I understand that, at my written request, I can receive additional explanation of the study after my child's participation is completed.

Signed \_\_\_\_\_

Date \_\_\_\_\_

Child's Name \_\_\_\_\_

Teacher \_\_\_\_\_



## APPENDIX H

### UNIVARIATE STEPDOWNS-EXPERIMENT II

## UNIVARIATE STEPDOWN-EXPERIMENT II

| <u>Source</u>         | <u>df</u> | <u>Variable</u> | <u>Mean Square</u> | <u>F</u> | <u>P</u> |
|-----------------------|-----------|-----------------|--------------------|----------|----------|
| Grand mean<br>between | 1, 46     | Constant        | 1137.6982          | 29.6338  | .0001    |
|                       |           | Linear          | 601.6251           | 8.3731   | .0059    |
|                       |           | Quadratic       | 8.3071             | 2.0452   | .1598    |
|                       |           | Cubic           | .0825              | .0271    | .8702    |
|                       |           |                 |                    |          |          |
| Group level           | 1, 46     | Constant        | 83.6455            | 2.1787   | .1468    |
|                       |           | Linear          | 115.4239           | 2.7822   | .1023    |
|                       |           | Quadratic       | 25.5810            | 3.2371   | .0789    |
|                       |           | Cubic           | 4.7241             | .6587    | .4219    |
|                       |           |                 |                    |          |          |
| Rehearsal             | 1, 46     | Constant        | 104.8528           | 2.7311   | .1053    |
|                       |           | Linear          | 68.5454            | 1.5203   | .2240    |
|                       |           | Quadratic       | 6.7158             | .1409    | .7093    |
|                       |           | Cubic           | 12.6961            | .0299    | .8636    |
|                       |           |                 |                    |          |          |
| Method I<br>+II       | 1, 46     | Constant        | 1296.5065          | 33.7706  | .0001    |
|                       |           | Linear          | 320.2041           | 3.7236   | .0600    |
|                       |           | Quadratic       | 10.9295            | .0016    | .9679    |
|                       |           | Cubic           | 18.7616            | 1.7705   | .1904    |
|                       |           |                 |                    |          |          |
| Method II             | 1, 46     | Constant        | 104.5451           | 2.7231   | .0158    |
|                       |           | Linear          | 136.4801           | 3.2388   | .0787    |
|                       |           | Quadratic       | 4.2665             | .0215    | .8841    |
|                       |           | Cubic           | 37.3721            | 1.6532   | .2054    |
|                       |           |                 |                    |          |          |
| G x R                 | 1, 46     | Constant        | 87.7380            | 2.2853   | .1375    |
|                       |           | Linear          | 48.7870            | 1.0706   | .3064    |
|                       |           | Quadratic       | 1.6901             | .0032    | .9551    |
|                       |           | Cubic           | 26.3918            | 1.2861   | .2631    |
|                       |           |                 |                    |          |          |
| G x M I +<br>II       | 2, 46     | Constant        | 197.7598           | 5.1511   | .0096    |
|                       |           | Linear          | 89.2236            | 1.6327   | .2068    |
|                       |           | Quadratic       | 5.5447             | .0410    | .9600    |
|                       |           | Cubic           | 5.5751             | .3921    | .6781    |
|                       |           |                 |                    |          |          |
| R x M I               | 1, 46     | Constant        | 39.3889            | 1.0260   | .3165    |
|                       |           | Linear          | 147.7692           | 3.8764   | .0552    |
|                       |           | Quadratic       | .2162              | .0610    | .8061    |
|                       |           | Cubic           | 64.2687            | 1.7041   | .1987    |
|                       |           |                 |                    |          |          |

| <u>Source</u>       | <u>df</u> | <u>Variable</u> | <u>Mean Square</u> | <u>F</u> | <u>P</u> |
|---------------------|-----------|-----------------|--------------------|----------|----------|
| R x M II            | 1, 46     | Constant        | 290.7832           | 7.5741   | .0085    |
|                     |           | Linear          | 1111.2269          | 25.6091  | .0001    |
|                     |           | Quadratic       | 2.5845             | 1.3293   | .2552    |
|                     |           | Cubic           | 6.4512             | .0097    | .9221    |
| G x R x M<br>I + II | 1, 46     | Constant        | 12.7434            | .3319    | .7193    |
|                     |           | Linear          | 171.4520           | 5.0806   | .0103    |
|                     |           | Quadratic       | 2.7445             | .0281    | .9724    |
|                     |           | Cubic           | 27.8254            | .7175    | .4949    |

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