The Effects of Input Organization and Rehearsal on the Rhythmic Short-Term Memory of Mentally Retarded and Nonretarded Subjects

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This study examines the influence of input organization and rehearsal strategies on the performance of a rhythmic imitation task. Subjects were mentally retarded adults and nonretarded individuals matched for chronological age (CA) and mental age (MA) respectively. Subjects (n=6 in each group) were seen individually, selected from a screening test, and trained prior to the experiment. The rhythmic imitation task contained 24 items, each composed of two four-beat phrases. Results from two 2x3 ANOVAs indicated that there were no differences between retarded and normal groups in overall rhythmic short-term memory. All groups performed significantly better on redundant versus non-redundant rhythmic patterns (p<.025) and on primacy versus recency patterns (p<.001). Significant interactions were found between groups and conditions of both input organization (p<.001) and rehearsal (p<.05). Although the need for input organization and rehearsal did affect the memory of all subjects, it had the least effect on the CA-matched nonretarded group. On an interactional basis, the retarded and MA-matched groups performed similarly on tasks measuring both input organization and rehearsal strategies. Future research examining short-term memory on musical versus verbal tasks was strongly suggested.

One measurable difference between mentally retarded and normal people is the ability to memorize a series of items. This difference is interesting not only for diagnosis, but also for understanding and helping the mentally retarded. The ability to memorize is itself complex and can be broken down into a number of processes.

Covert memory processes are those unobservable mental operations that an individual uses to organize and remember a stimulus. Two mental operations of particular interest in these processes are input organization and rehearsal strategies.

Input organization refers to those operations used by an individual to
recognize and group together repeated elements of a stimulus so that they can be stored and recalled more easily (Miller, 1956; Spitz, 1963). A rehearsal strategy is any attempt to mentally practice a stimulus in order to hold it in memory (Ellis, 1970).

Because short-term memory (STM) has been found to be closely related to intelligence (Belmont & Butterfield, 1969; Ginsburg & Opper, 1979), input organization and rehearsal strategies have received a great deal of attention in research concerning STM. Theorists have proposed that retarded individuals have physiological defects which account for their inferior performance on STM tasks (Ellis, 1963; Spitz, 1964). These defects, which affect the mechanisms underlying STM, result in little or no attempt to organize or memorize incoming information (Brown, 1974). Because input organization and rehearsal strategies help individuals organize and memorize information, these mechanisms become paramount in the study of STM.

INPUT ORGANIZATION

Theorists and researchers believe that the amount of incoming material an individual can recall may be increased by clustering or combining small "bits" of information into "chunks" (Miller, 1956; Spitz, 1966). Another method of input organization that facilitates recall is recognizing any redundancies that occur in incoming material. Chunking and recognizing redundancies serve to reduce the load of to-be-remembered material, thereby increasing input capacity for STM.

Theorists believe that retarded persons have memory problems because they do not cluster elements within a stimulus effectively.

In a great many instances the retardate's slower learning will be hampered by a deficit in the organization or grouping of the material to be learned. When, for example, the task is to reproduce six digits, if during the initial presentation normals tend to cluster the digits into two groups of three digits each and the retardates do not, then in essence the retardates are attempting to learn more bits of information than are the normals. (Spitz, 1966, p.33)

However, research studies comparing retarded individuals to mental age(MA)-matched nonretarded subjects on tasks measuring input organization have yielded conflicting results. While the findings of Iscoe & Semler (1964) and Jensen (1965) found the retarded groups to be inferior to the normal groups, other studies revealed no such differences (Cantor & Ryan, 1962; Ring & Palermo, 1961). It is important to note, however, that while the studies which revealed no differences between the retarded and nonretarded groups used subjects with mean IQs in the 70s, the studies which revealed differences between the two groups used retarded subjects with mean IQs in the 50s. The level of retardation, then, may be an important factor in assessing the capacity for input organization.

With regard to comparing retarded and chronological age(CA)-
matched normal subjects, findings seem to be more consistent. Nonre­
tarded groups seem to organize material much more efficiently than re­

The typical methods of testing input organization include asking sub­
jects either to verbally recall digits and/or words, or to group picture cards. These tasks are amenable to categorization (Cantor & Ryan, 1962; Dallett,
1964; Iscoe & Semler, 1964; Jensen, 1965; MacMillan, 1970; O’Connor &

Although research suggests that retarded individuals do not cluster
spontaneously (Spitz, 1966; Wallace & Underwood, 1964), the general
finding is that they can learn to use the redundancy present in materials, provided the redundancy level is high (Brown, 1974). Studies have also
shown that when incoming information is grouped in advance, recall
improves markedly (Dallett, 1964; Spitz, 1966). Organizing material prior
to presentation, then, appreciably improves the retarded subject’s per­
formance on STM tasks.

It has been suggested that in order to efficiently use redundancy to
organize incoming material, teachers must also consider the learner’s
knowledge of the structure of the material (Moe & Harris, 1983; Spitz &
Webreck, 1972). Thus, in addition to carefully organizing the material to
aid in recall, its redundancy, or susceptibility to categorization, must be
readily apparent.

Music’s rhythmic element provides the sort of structure described by
Spitz & Webreck (1972), and imposes an order to the presented material
(Jellison & Miller, 1982). Rhythm is “a sequence of sounds of varying
durations and emphases that are temporally organized or grouped in rela­
tion to each other and/or to an underlying pulse” (Bruscia, 1979, p.7). The
organization inherent in rhythm is supported by the research of Bower
(1970) and Dowling (1973), who concluded that “rhythmic grouping
determines the form of subjective chunks, and that chunk contents in turn
determine how the list items are stored” (p.39).

Rhythmic imitation tasks easily lend themselves to the study of input
organization. With effective use of input organization, a rhythm pattern
such as  m1 m1, for example, would be conceived of as one motif ( m1 ),
repeated twice (Bruscia, 1981). Unfortunately, there is a paucity of
research examining input organization among the mentally retarded
through the musical mode. The idea that auditory, non-verbal test items
may elicit different responses in terms of input organization than the more
usual testing modalities (e.g., visual/verbal digit series, word lists, paired­
associate pictures) is worthy of consideration (Maranto, Decuir &
Humphrey, 1984).

REHEARSAL STRATEGIES

Rehearsal strategies are those processes used by an individual to
mentally practice a stimulus in order to hold it in memory. Theories
suggest that it is necessary to rehearse initial segments or items presented in a series, since they must be held in STM longer (Ellis, 1970). The absence of rehearsal is most often demonstrated by a failure to recall initial segments or by low "primacy" scores. Rehearsal seems to have little bearing upon final segments or "recency" scores. In other words, individuals who do not rehearse a serial stimulus will recall the final or recency items more accurately than the initial or primacy items. Ellis (1970) found that although retarded individuals were equal to their nonretarded peers in recalling final segments of a digit sequence, they were inferior in recalling initial segments. His contention was that poor rehearsal strategies are due to a weak stimulus trace as a result of central nervous system pathology (Ellis, 1963).

Evidence for such rehearsal inadequacy in the mentally retarded is quite substantial. Studies comparing mentally retarded and MA-matched subjects on tasks measuring rehearsal strategies have found the retarded group to be inferior (Hermelin & O'Connor, 1964; Reid, 1980). Studies comparing mentally retarded to CA-matched normals have also found the retarded group to be inferior (Belmont & Butterfield, 1971; Reid, 1980).

Typical methods of testing rehearsal strategies include verbal responses to digits and/or word lists (Belmont & Butterfield, 1971; Hermelin & O'Connor, 1964; Kellas, Ashcraft & Johnson, 1973; O'Connor & Hermelin, 1965), non-verbal responses to digits (Ellis, 1970), and more recently, non-verbal motor responses (Horgan, 1983; Reid, 1980).

There seem to be two additional factors which affect the success of the retarded in using rehearsal strategies: the rate of presentation of the material, and the opportunity for overt rehearsal. At faster speeds of presentation, subjects tend to forget recency segments, whereas at slower speeds, they tend to forget primacy segments (O'Connor & Hermelin, 1965). The rate of one digit per 0.66 second has been found to be an optimal presentation rate (O'Connor & Hermelin, 1965).

Overt rehearsal refers to those observable operations used to practice a stimulus in order to hold it in memory. Methods most often include verbal practice (Butterfield, Wambold & Belmont, 1973; Kellas, et al., 1973) and motor practice (Horgan, 1983). These studies have shown that overt rehearsal enhances recall.

When the concept of rehearsal strategies was applied to musical memory tasks, research indicated that individuals tend to forget the initial segment more readily than the final segment (Williams, 1975). Also, memory decreased as the musical task got longer (Long, 1977). Because these tests were conducted on college students, conclusions cannot necessarily be drawn with regard to retarded individuals. Again, there is little research material from which to draw conclusions. One study was found, however, specifically comparing the rhythmic imitation abilities of retarded children and their MA-matched counterparts (Kaplan, 1977). Children in the normal group were found to be superior. The study did not address the issue of primacy versus recency.
Bruscia (1979) used rhythmic imitation to examine STM among the mentally retarded. Although the process under direct examination was selective attention, he also explored the relevance of input organization and rehearsal strategies. He stated, "These findings do not imply that STM is solely dependent upon selective attention, or that rehearsal strategies and input organization are not also involved. Nor do they imply that an inadequacy in selective attention is the singular cause of STM deficiencies" (Bruscia, 1979, p.88). It was recommended that further investigation include the other processes (i.e., input organization and rehearsal strategies) as well, possibly examining their interdependence. It was also suggested that more research be done through the auditory modality, as experiments in the visual modality are far more abundant.

Rhythmic imitation is an auditory modality which can readily examine the interdependence of input organization and rehearsal strategies. Rhythm patterns can be combined in different ways to form both redundant and non-redundant test items. One task, then, can measure the interrelationship of the two memory processes.

Because experimenters have generally studied two groups at one time on a particular task (e.g., mentally retarded versus CA-matched normal subjects or mentally retarded versus MA-matched normal subjects), it is difficult to ascertain the similarities and/or differences between the three groups. The purpose of this study, then, was to compare the STM processes of input organization and rehearsal strategies through the responses to one task across three populations (i.e., mentally retarded adults, their CA-matched counterparts, and their MA-matched counterparts). In other words, does the rhythmic STM of retarded persons differ from CA-matched and MA-matched nonretarded groups as a result of input organization requirements and/or rehearsal needs of the task?

The subordinate questions of the study with regard to input organization were:

1. Will STM vary according to group across both conditions of input organization? That is, how will mentally retarded adults compare to their CA and MA peers in the ability to reproduce both redundant and non-redundant rhythm patterns?

2. Will STM vary according to the need for input organization across all three groups? That is, will all three groups perform better on the redundant or non-redundant patterns?

3. Will any STM differences between the two input organization conditions vary according to group? That is, do mentally retarded individuals exhibit a greater difference in scores on the redundant versus non-redundant patterns than the other two groups?

The subordinate questions of the study with regard to rehearsal strategies were as follows:

1. Will STM for patterns requiring rehearsal strategies vary according to group? That is, how will mentally retarded adults compare to
their CA and MA peers in the ability to produce patterns requiring rehearsal?

2. Will STM vary according to the need for rehearsal across all three groups? That is, will the groups differ according to primacy or recency patterns?

3. Will any differences in primacy versus recency performance vary according to group? That is, will the mentally retarded individuals exhibit a greater difference in primacy and recency performance than the other two groups?

The null hypothesis was assumed on all subordinate questions.

**METHOD**

**Subjects**

Subjects for the study consisted of one group of mentally retarded adults and two groups of nonretarded individuals, one matched in chronological age and the other matched in mental age. Selection criteria for all subjects included: (a) no past or present experience with private musical instruction, (b) no emotional or behavioral problems that would interfere with the task, (c) no sensory or motor problems that would interfere with the task, (d) the ability to score 50% on a preliminary screening test, and (e) agreement to participate in the study.

The retarded group (n=6) was associated with the Community Organization for Mental Health and Retardation in Philadelphia. In addition to meeting the aforementioned criteria, all mentally retarded subjects met the diagnostic criteria for borderline, mild, or moderate mental retardation as specified by the American Association for Mental Deficiency (Grossman, 1973). These criteria include having an IQ which falls into one of the three previously mentioned mental retardation categories as measured by a test of mental abilities (Grossman, 1973), and being over 21 years of age and unable "to maintain himself independently in the community and in gainful employment" (Grossman, 1973, pp.13-14). The subjects' IQ scores ranged from 39-83 as measured by the Stanford-Binet or Wechsler Adult Intelligence Scale ($\bar{X} = 61.5$). The subjects' chronological ages ranged from 22.0 to 42.5 years ($\bar{X} = 30.3$).

The chronological age-matched group (n=6) consisted of nonretarded adults who met the aforementioned criteria. In addition, all of the subjects were living independently in the city of Philadelphia and had no past or present diagnosis of mental retardation. They were selected on the basis of having a birthday no more than six months away from a corresponding subject in the mentally retarded group. The subjects' chronological ages ranged from 21.7 to 42.0 years ($\bar{X} = 30.6$).

The mental age-matched group (n=6) consisted of nonretarded children who met the aforementioned criteria. In addition, all of the subjects were enrolled in second grade at a public school in New York. None of the
children was enrolled in remedial or gifted education programs. They were selected on the basis of having their 8th birthday no more than six months away from the testing date. Age 8 was selected as the mental-age match because previous researchers have shown that 8-year-olds perform rhythmic imitation tasks with at least 50% accuracy (Gardner, 1971; Thackray, 1972).

Participation in the study was on a voluntary basis. Permission was granted from each subject. In addition, authorization to conduct the experiment was obtained from the facilities responsible for both the retarded adults and the MA-matched children.

**Apparatus**

The following equipment was used in the preliminary screening test, training session, and actual experiment: one snare drum, two mallets, one portable cassette recorder, and TDK D-120 cassette tapes.

Each subject was seen individually in a private room. The drum was placed approximately five feet from a corner, equidistant from two walls. Both mallets were placed on the drum head. The subject and experimenter were seated side by side, facing the drum and the corner. The subject was asked to use one drumstick, and the experimenter used the other. The tape recorder was placed under the experimenter's chair.

**Procedures**

A preliminary screening test and a training session were administered to each subject prior to the experimental session. All three sessions were conducted and tape recorded in a one-on-one setting. To elicit imitation of the rhythms, the subjects were asked to “Listen carefully and play exactly what I play.” The experimenter then played a rhythm pattern and cued the subject when to respond. The experimenter's response to the subject's attempt at imitation differed in the three sessions as described below.

**Preliminary screening test.** If the subject's response was correct on the first trial, the next item was then presented. If the response was incorrect, the same test item was immediately repeated by the experimenter, accompanied by a verbal prompt which coincided with the rhythm. For example, “Play on the drum” was spoken in the rhythm of the pattern

\[
\text{\(\text{Play on the drum}\)}
\]

The purpose of the screening test was to evaluate the imitation abilities of each subject and to ascertain the potential success of training for each individual. The test contained twenty-four rhythm patterns (see Materials).

**Training session.** If a subject imitated a rhythm incorrectly, it was immediately repeated by the experimenter with verbal assistance, as previously described. If it was again imitated incorrectly, it was again repeated by the experimenter with verbal and hand-over-hand physical assistance. Assistance was given as needed, and the training continued until the subjects
could imitate each rhythm twice with no assistance. The purpose of the training session was to insure that all subjects could accurately reproduce each rhythm pattern with no assistance. Because this study was designed to examine memory processes, it was important to establish that if a rhythmic imitation task was incorrectly reproduced during the actual test, it was more likely attributable to a memory dysfunction than to an inability to reproduce the pattern. The training session was designed to practice the ten rhythm patterns used in constructing the test items (see Materials).

Experimental session. Each test item (see Materials) was presented to each subject only once. After the subject imitated the rhythm the experimenter said, “Here is the next one. Are you ready?” When the subject answered affirmatively, the test was continued. The twenty test items were presented to each subject in an invariant sequence. The experimental session was taped for scoring purposes. The objective of the experiment was to examine the rhythmic short-term memory processes of input organization and rehearsal.

Materials

The preliminary screening consisted of twenty-four rhythm patterns which were constructed according to the following criteria:

1. All patterns were organized in relation to four equal beats. Each beat had the time value of a quarter note (\( \frac{1}{4} \)), and was equivalent in time to one second. (On a metronome, \( \frac{1}{4} = 60 \)).

2. Each beat contained taps of varying durations.

$$
\text{\( \{, \\{ \text{taps of varying durations}\}\} \)}
$$

3. The taps were arranged within each beat in the following ways:

$$
\begin{array}{cccc}
\text{\( \{, \\{ \text{arranged within each beat}\}\} \)}
\end{array}
$$

4. Each rhythm pattern consisted of a sequence of two beats described above, followed by a quarter note on the third beat and a rest (silence) on the fourth beat (e.g., \( \{, \\{, \\{, \\}\} \) ).

Tapes of the preliminary screening test were analyzed to determine the frequency of correct responses for each rhythm pattern. The patterns which were imitated with at least 90% accuracy after two trials were selected for the final test (see Table I). These ten rhythm patterns were subsequently practiced in the training session.

As shown in Table 2, each of the ten rhythm patterns was assigned an alphabetical letter. The items were then paired as follows: A with B, C with D, E with F, G with H, and I with J. Each of the five pairs generated four
### TABLE 1

**% of Correct Responses on a Preliminary Screening Test**

<table>
<thead>
<tr>
<th>Order of Presentation</th>
<th>Rhythm Pattern</th>
<th>% Correct 1st Trial</th>
<th>% Correct 2nd Trial</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>88.89</td>
<td></td>
<td>88.89</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>3</td>
<td></td>
<td>88.89</td>
<td>5.56</td>
<td>94.45</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>72.22</td>
<td>16.67</td>
<td>88.89</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>77.78</td>
<td>5.56</td>
<td>83.34</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>100</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>61.11</td>
<td>27.78</td>
<td>88.89</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>94.45</td>
<td>5.56</td>
<td>100</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>88.89</td>
<td>5.56</td>
<td>94.45</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>77.78</td>
<td>5.56</td>
<td>83.34</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td>66.67</td>
<td>16.67</td>
<td>83.34</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td>72.22</td>
<td>16.67</td>
<td>88.89</td>
</tr>
<tr>
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<td>72.22</td>
<td></td>
<td>72.22</td>
</tr>
<tr>
<td>14</td>
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<td>94.45</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>66.67</td>
<td>5.56</td>
<td>72.22</td>
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<td>17</td>
<td></td>
<td>61.11</td>
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<td>18</td>
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<td>88.89</td>
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<td>24</td>
<td></td>
<td>38.89</td>
<td>16.67</td>
<td>55.56</td>
</tr>
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</table>
test items (e.g., AA, BB, AR, BA), thus producing twenty test items.

Of the twenty test items produced, there were ten redundant test items and ten non-redundant test items. The ten redundant items (e.g., AA and BB) were compared to the ten non-redundant test items (e.g., AB and BA) to measure input organization, or the ability to recognize and group together repeated elements of a stimulus.

The ten non-redundant test items (e.g., AB and BA) were also used to measure rehearsal strategies, or the ability to mentally practice a stimulus in order to hold it in memory. The twenty test items were subjected to a one order randomization, then presented to each subject in the same sequence (see Table 3).

**Scoring**

The experimenter scored the results of the test by comparing the tape-recorded responses of each subject, rhythm pattern by rhythm pattern, with the stimulus presented. A rhythm pattern was considered correct when it contained the same relative duration and correct order of taps as the corresponding rhythm pattern in the stimulus. Correct imitation of each rhythm pattern earned 1 point. There was no partial credit for a
### TABLE 3

**Test Items**

<table>
<thead>
<tr>
<th>Order of Presentation</th>
<th>Rhythm Pattern Combination</th>
<th>Item</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>II</td>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
</tr>
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<td>AA</td>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>3</td>
<td>JI</td>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
</tr>
<tr>
<td>4</td>
<td>BA</td>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
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<td>5</td>
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<tr>
<td>20</td>
<td>DD</td>
<td>1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1</td>
</tr>
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</table>
partially correct rhythm pattern. The distribution of points for input organization and rehearsal strategies are as follows:

*Input organization.* The twenty rhythmic test items were divided into two categories. Those with redundant rhythm patterns were compared to those with non-redundant rhythm patterns to examine the effects of input organization. Each rhythmic test item had two patterns (e.g., A and A, A and B). Each rhythm pattern, then, was worth a total of two points. Since there were ten rhythmic test items in each category (i.e., redundant test items and non-redundant test items), each category was worth a maximum of 20 points.

*Rehearsal Strategies.* The ten non-redundant test items were further examined to measure the effects of primacy versus recency. Correct imitation of the first rhythm pattern of a non-redundant test item (e.g., A

### TABLE 4

Ranges, Means and Standard Deviations for Input Organization

<table>
<thead>
<tr>
<th>Group</th>
<th>Redundancy Scores</th>
<th>Non-redundancy Scores</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>Retarded</td>
<td>8-20</td>
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<td></td>
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<td>18.83</td>
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<td></td>
<td>7-19</td>
<td>12.67</td>
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<tr>
<td>MA-matched group</td>
<td>14-20</td>
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<td></td>
<td>6-16</td>
<td>9.33</td>
</tr>
</tbody>
</table>
of AB) earned 1 point for primacy. Correct imitation of the second rhythm pattern of a non-redundant test item (e.g., B of AB) earned 1 point for recency. Since there were ten non-redundant test items, each category (i.e., primacy and recency) was worth a maximum total of 10 points.

### TABLE 5

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Squares</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>1106</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between subjects</td>
<td>385</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditions</td>
<td>88</td>
<td>2</td>
<td>44</td>
<td>2.23</td>
</tr>
<tr>
<td>Error b</td>
<td>296</td>
<td>15</td>
<td>19.73</td>
<td></td>
</tr>
<tr>
<td>Within subjects</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trials</td>
<td>417</td>
<td>1</td>
<td>417</td>
<td>74.46</td>
</tr>
<tr>
<td>Trials x Conditions</td>
<td>220</td>
<td>2</td>
<td>110</td>
<td>19.64</td>
</tr>
<tr>
<td>Error w</td>
<td>84</td>
<td>15</td>
<td>5.6</td>
<td></td>
</tr>
</tbody>
</table>

### RESULTS

#### Input Organization

Table 4 shows ranges, means, and standard deviations for each group, for both redundancy and non-redundancy scores. A 2x3 analysis of variance (ANOVA) for repeated measures (Bruning & Kintz, 1977) was used to determine if short term memory varied according to group, input organization, or both. In addition, an F-Test for Simple Effects (Bruning & Kintz, 1977) was used to determine the size of the differences. As shown in Table 5, the results were as follows:

1. Significant differences were not found between the three groups in their ability to reproduce rhythms across both conditions of input organization (i.e., redundancy and non-redundancy) (p > .05).

2. Significant differences were found between the ability of the three groups to perform redundant versus non-redundant patterns, favoring redundancy (p < .025).

3. A significant interaction was found between group and condition of input organization. Further analysis revealed that the nonretarded Ca-
TABLE 6

Ranges, Means and Standard Deviations for Rehearsal Strategies

<table>
<thead>
<tr>
<th>Group</th>
<th>Primacy Scores</th>
<th>Recency Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range</td>
<td>Mean</td>
</tr>
<tr>
<td>Retarded</td>
<td>1-8</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>2-4</td>
<td>3.17</td>
</tr>
<tr>
<td>CA-Matched Group</td>
<td>5-10</td>
<td>7.16</td>
</tr>
<tr>
<td></td>
<td>2-9</td>
<td>5.5</td>
</tr>
<tr>
<td>MA-Matched Group</td>
<td>3-10</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>2-6</td>
<td>3.5</td>
</tr>
</tbody>
</table>

The matched group imitated both redundant and non-redundant patterns with significantly greater accuracy than the other two groups (p < .001). Performance across both conditions of input organization was not significantly different between the mentally retarded and nonretarded MA-matched groups (p > .05).

Rehearsal Strategies

Table 6 shows ranges, means, and standard deviations for each group in terms of rehearsal strategies. A 2x3 ANOVA for repeated measures (Bruning & Kintz, 1977) was used to determine if STM varied according to group, need for rehearsal, or both. In addition, an F-Test for Simple Effects (Bruning & Kintz, 1977) was used to determine the size of the differences.

As shown in Table 7, the results were as follows:
1. Significant differences were not found between the groups in their use of rehearsal strategies (p>.05).

2. Significant differences were found between primacy versus recency scores, favoring the primacy scores (p<.05).

3. A significant interaction was found between group and the need for rehearsal (p<.05).

DISCUSSION

The conclusions of this study are delimited by its small sample size (n=6 in each group) and its testing modality (non-verbal, musical). Furthermore, any generalizability is limited to retarded subjects with a mean IQ in the low 60s, with respect to non-verbal musical stimuli.

Results indicated that the three groups performed similarly on STM tasks. As mentioned earlier, level of retardation is an important factor when measuring input organization skills. Although the present results contradict findings of previous research with retarded subjects having IQs in the 50s (Iscoe & Semler, 1964; Jensen, 1965), they are similar to results found in subjects with mean IQs in the 70s (Cantor & Ryan, 1962; Ring &

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TABLE 7

Results from 2x3 ANOVA Grouped by Rehearsal

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Squares</th>
<th>F-Ratio</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>202</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between subjects</td>
<td>159</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditions</td>
<td>46</td>
<td>2</td>
<td>23</td>
<td>3.05</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Error</td>
<td>113</td>
<td>15</td>
<td>7.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within subjects</td>
<td>43</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trials</td>
<td>26</td>
<td>1</td>
<td>26</td>
<td>35.62</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Trials x Conditions</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>4.11</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Error</td>
<td>11</td>
<td>15</td>
<td>.73</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Perhaps then, mentally retarded adults with mean IQs in the low 60s are comparable to higher functioning retarded subjects in the use of input organization.

In terms of rehearsal strategies, previous literature has overwhelmingly suggested that mentally retarded subjects are inferior to both MA- and CA-matched subjects. The disparity between the results of past experiments and the present study suggests, in addition to IQ variability, the possibility that verbal stimuli are more commonly used in examining rehearsal strategies.

Although no differences were found between retarded and nonretarded groups in overall rhythmic STM, the need for input organization and rehearsal did affect the memory of all groups. In terms of input organization, redundant rhythms were more accurately recalled than nonredundant rhythms. This finding corroborates Bruscia's (1979) suggestion that with effective use of input organization, a rhythm pattern such as [M1 M1] would be conceived of as one motif ([M1] repeated twice. While all groups performed better on the redundant patterns, the nonretarded CA-matched group imitated the nonredundant patterns more accurately than did the other two groups. It seems, then, that organizing material prior to presentation appreciably improves the performance of all groups. However, the CA-matched nonretarded group more efficiently organizes material with redundancy that is not so readily apparent.

Are retarded adults similar to MA-matched nonretarded subjects in their use of input organization? O'Connor & Hermelin (1963) found that when the stimulus was highly conducive to organization, retarded subjects with IQs in the 40s performed as well as MA-matched subjects. This study suggests that retarded subjects with IQs in the low 60s perform as well as MA-matched nonretarded subjects whether or not the stimulus is conducive to organization.

In terms of rehearsal strategies, primacy patterns were more accurately recalled than recency patterns. Contrary to Ellis' (1970) work, this study provides evidence that the mentally retarded group (as well as the other groups) did indeed employ a rehearsal strategy in order to hold the primacy segment in memory. The present results are supported by Bruscia's (1979) findings that primacy scores were higher than recency scores for mentally retarded subjects on rhythmic imitation tasks.

According to Ellis' (1970) theory, poor primacy performance results when initial segments of the stimulus are not rehearsed while being replaced in the memory store by later or final segments. This proposition is based on the assumption that both initial and final segments are in fact registered in the memory store. The present findings suggest that this may not necessarily be the case. Since initial segments were recalled better than final segments, the possibility exists that the final segments were not even registered in the memory store. In addition, Ellis' findings indicate that when confronted with the necessity of simultaneously rehearsing initial segments while registering incoming segments,
mentally retarded subjects tend to only register incoming segments. The present findings suggest the opposite. Subjects apparently rehearsed initial segments but did not always register later incoming segments. (Bruscia, 1979, pp.76-77)

The issue of whether recency items are not registered or not rehearsed still remains, but evidence is quite strong that primacy patterns are indeed rehearsed.

While all groups performed better on the primacy patterns, the CA-matched nonretarded group imitated the recency patterns more accurately than did the other two groups. This finding lends support to evidence that normal adults can effectively remember longer tasks (e.g., lists, numbers, rhythms) than their retarded counterparts (Ellis, 1963). Also, the retarded and MA-matched nonretarded group scored similarly on the recency patterns. This suggests that mentally retarded and MA-matched nonretarded subjects might employ similar rehearsal strategies, specifically for recency items. Such a suggestion concurs with Chi (1976), who believes that memory strategies improve with intellectual development.

**SUMMARY AND CONCLUSIONS**

The statistical analysis of the present study indicates that the three groups under examination performed similarly on STM tasks. Differences emerged, however, favoring responses to redundant patterns over nonredundant patterns, and to primacy patterns over recency patterns. The need for input organization and rehearsal did affect the memory of all subjects, but it had the least effect on the CA-matched nonretarded group. On an interactional basis, the retarded group and the MA-matched nonretarded group performed similarly on tasks measuring both input organization and rehearsal strategies.

Although the overall results were parallel for both input organization and rehearsal strategies, the interdependence of these two processes was not clearly defined. Such parallel results seem to indicate that a relationship may exist, an important issue for future research. Are STM processes interrelated? If so, how? This investigation, in addition, yielded relatively higher results for the mentally retarded group than previous experiments with STM. As mentioned earlier, this discrepancy may be due to either an IQ difference between this and other studies, or to the difference in testing modalities. Are musical stimuli processed differently than verbal stimuli? To answer such a question, experimenters could begin by comparing the responses of various groups using STM processes on musical versus verbal tasks.

The possibility of a processing differences is certainly worthy of consideration, particularly if it can provide some insight into the covert memory processes of the mentally retarded. In addition, if musical stimuli are indeed processed differently than verbal stimuli, this would have tremendous implications for clinical work in music therapy. It could be an invaluable tool in both measuring STM skills and in enhancing them.
REFERENCES


Rhythmic Short-term Memory of Subjects


Angela Santamaria-Luftig, RMT-BC, received her B.M. at SUNY College at Fredonia and her M.M. at Temple University. She has worked as a music therapist with mentally retarded children and adults, and as an internship supervisor with Molloy College in New York.