Specific Patterns of Cognitive Abilities in Young Children with Mild Mental Retardation

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Abstract: Whereas a wealth of research has examined cognitive abilities of groups of individuals with mild mental retardation (MMR), less research has investigated potential differences in cognitive performance among individuals with mental retardation (Baumeister, 1997). The present study was an exploratory analysis of variability in performance of children with MMR on a wide range of cognitive tasks. Four-, 5, and 6-year-old children were presented with 10 cognitive tasks designed to tap different underlying processes. Children’s performance on each of these tasks was only moderately correlated with IQ scores. Cluster analysis revealed four clusters of young children with MMR that were differentiated by their patterns of cognitive performance across the 10 tasks. Patterns of cognitive performance are described for each cluster and implications of this research are discussed.

Over the past several decades, researchers have attempted to determine which specific cognitive processing ability is deficient in individuals with mild mental retardation (MMR). Specific areas of cognitive deficits in individuals with MMR that have been proposed include an attention deficit (Zeaman & House, 1963), a short-term memory deficit (Ellis, 1963), and a memory strategy deficit (Belmont & Butterfield, 1971) to name a few. Unfortunately, when compared to individuals without MMR, individuals with MMR demonstrate deficits in almost every type of cognitive task (Detterman, 1987).

As further evidence for this general cognitive deficit in individuals with MMR, Detterman et al. (1992) compared individuals with MMR and college students on a battery of nine tasks examining various components of information processing. Of the 31 measures examined, individuals with MMR performed significantly lower than the college students on 24 measures. As well, in a series of studies, Fletcher, Scott, Deuel, and Jean-Francois (1999) found that on 20 different cognitive tasks which required processing abilities such as memory, perception, and conceptual knowledge, 4-, 5- and 6-year-old children with MMR performed more poorly than children without MMR of the same age on every task. These studies, as well as previous decades of research on mental retardation, indicate that there is, thus far, no evidence of a specific deficit associated with mild mental retardation.

Rather than researchers identifying a specific cognitive deficit in individuals with MMR, instead, it is more likely that there are complex interrelations between different components of processing in all individuals, including individuals with MMR (Detterman et al., 1992). And in fact, the interrelations and/or performance profiles for various cognitive abilities may differ across individuals. There is some evidence that individuals with MMR might also demonstrate different strengths and weaknesses depending on the cognitive task. Detterman et al. found that there was greater variability in the performance of indi-
viduals with MMR compared to the college students, with the standard deviations within the group of individuals with MMR sometimes 4 to 5 times larger than for the college students. Fletcher, Huffman, Bray, and Grupe (1998) also found variability in the rate, frequency, and the generalization of strategy use among children with MMR, with a subset of children with MMR exhibiting the same sequence of strategy discovery and use as their same age peers without MMR. Other research has also reported variability in the cognitive performance of individuals with MMR (Baroody, 1986, 1996; Carlin, Soraci, Goldman, & McIvane, 1995; Naglieri, 1982). Baumeister (1997) has further suggested “...we have repeatedly shown that a group of people with mental retardation exhibit much more interand intraindividual variability on dependent measures than so-called ‘normals’” (p. 10). Yet this variability is rarely the focus of specific research questions with comments on the variability observed included merely explaining overall results.

Investigation of individual differences of cognitive performance among individuals with MMR has been largely ignored. In reviewing research on mental retardation, Baumeister (1997) argued that the tendency to consider individuals with MMR as a heterogeneous group has limited the ability to discover individual differences within MMR groups. Methodologies that focus on group means and the comparison of individuals with and without MMR have led to an assumption that individuals with MMR have similar processing deficits (Baumeister, 1997). In a call to broaden research on individuals with MMR, Baumeister states “...emphasis should shift away from nonproductive efforts to decompose and predict IQ, and more toward how individuals process information in different contexts...” (p. 12). Recently, within the discipline of developmental psychology, researchers have begun to emphasize individual differences in the cognitive performance of children of the same age (e.g., Siegler, 1996).

Understanding an individual’s unique cognitive strengths and weaknesses is an important endeavor given that education plans must be individualized for each exceptional student (Detterman & Thompson, 1997). Reaching this goal, however, requires a much greater knowledge base on potential individual differences in cognitive abilities of exceptional students. Researchers that have investigated behavioral and cognitive profiles of individuals with different genetic syndromes related to mental retardation have made progress toward this goal (Dykens & Hodapp, 2001). Thus, a greater research focus on individual differences within groups of exceptional students, such as individuals with MMR, is necessary in order to examine potential differences in the patterns of abilities exhibited on different cognitive tasks.

The purpose of the present study was to explore patterns of performance of 4-, 5-, and 6-year-old children with MMR on a variety of cognitive tasks. Cognitive tasks included oddity, relative size, sequencing, oppositional concepts (i.e., in and out), phonological awareness, and conceptual knowledge. These tasks have been used previously to differentiate children with MMR from children without MMR (Deuel, 1997; Scott, Fletcher, & Deuel, 1998). This study represents an exploratory analysis of specific patterns of cognitive performance among children with MMR. Given the exploratory nature of our analysis, our interest is not in establishing “subgroups” of children with MMR per se, but rather to demonstrate that children with MMR within a narrow range of IQ scores (IQ score range = 42 – 73) display different cognitive profiles. Through this analysis, we emphasize the need to examine variability within groups of individuals with developmental disabilities in future research.

The following questions were addressed: a) Do the cognitive tasks examined relate to IQ scores? b) Are there intercorrelations among the cognitive tasks examined? and c) Are there clusters of individuals with MMR that display different patterns of performance over the cognitive tasks examined?

**Method**

**Participants**

The sample described was part of a larger study that included children with MMR, children with learning disabilities (LD), and children without disabilities (Deuel, 1997). For the purposes of this study, we will report information only for the children with MMR and children with LD. The sample was 88, 82...
of whom had available IQ scores (Mean (M) = 90, Standard Deviation (SD) = 22).

There were 27 children classified as MMR. Children were recruited from the same school district and were enrolled in classes for the educable mentally handicapped. The procedure for identifying and classifying children as educable mentally handicapped and learning disabled is described in detail in Scott et al. (1998). IQ data for students with MMR were obtained from computerized school records. IQ scores were available for 23 of the 27 children with MMR and the group had a mean IQ of 63 (SD = 7.2; range = 42-73). Only one child had an IQ score below 50. There were 12 females and 15 males and the mean chronological age was 65 months (SD = 8.4; range = 49-79). The race/ethnicity distribution was 11 Black/non-Hispanics, 11 White/Hispanic, one White/non-Hispanic and four children included in the “Other” category.

There were 61 children with LD in this sample. IQ data were available for 59 of the 61 children with LD. The mean IQ score was 101 (SD = 16.3; range = 80–146). There were 14 females and 47 males and the mean age of the children was 65 months (SD = 6.6; range = 52–78 months). The race/ethnicity distribution of this group was six Black/non-Hispanics, 51 White/Hispanics, and three White/non-Hispanics, and one child classified as “Other.”

Materials and Procedure

Children were seen individually by one of several testers for a single session. For all but the word meaning task, colored pictures or dots were photocopied onto 35.6 (wide) × 21.6 (high) white paper and a complete set of stimuli was placed into a black legal size binder. Seven tasks required children to simply identify the correct answer (i.e., identification tasks) and three tasks required children to generate the correct response on their own (i.e., generating tasks). All tasks are described below in the order in which they appeared in the screening test.

Relative size task. This task consisted of six pages, on each of which appeared a small, medium and large object or picture (e.g., dinosaur). The medium size picture was 1.5 times the size of the small picture and the large picture was 1.5 times the size of the medium size picture. The children were asked to point to the biggest or the littlest picture. The dependent measure was the percentage correct out of six.

Pointing task. Children were asked to point to each of six pictures on each of four cards. The children’s pointing sequences were scored 3 (reading order), 2 (systematic), 1 (non-systematic) or 0 (errors committed) and the dependent measure, quality score, was the sum of scores over the four arrays. The dependent measure was total number of points awarded divided by 12, which was the highest score possible.

Phonological awareness task. This task consisted of six pages. On each were two items whose labels began with a different sound (e.g., door and book). The testers named each of the pictures and then asked the children, for example, to point to the one that begins with “duh, that starts with duh.” The children were pretrained with a single example. The dependent measure was percent correct out of six.

Oddity task. This task consisted of six, three-picture arrays, on each of which were displayed two identical and one different picture. The children were asked to point to the different picture, the one that didn’t belong, that didn’t have a buddy. Incorrect responses were corrected on no more than three arrays but only the first response was scored. The dependent measure was the percentage correct out of six.

Rhyming task. There were six pages of stimuli for this task. On each were two pairs of pictures; one picture pair whose names rhymed and the other whose names did not rhyme. One pair appeared on the top of the page over a thick black line that bisected the page horizontally, and the other pair was below that black line. One set of pictures rhymed in English (e.g., man/fan) and another set rhymed in Spanish [e.g., peso (dollar) versus queso (cheese)]. The English labels were one syllable in length and the Spanish names were two syllables. The children were asked to point to the pair whose names sounded the same. There was a single pretraining example for this task. The dependent measure was the percentage correct out of six.

Sequencing task. For this task, a horizontal array of colored dots (3 pages) or animals (3 pages) appeared on the top of the page with the last position in the array represented by an
unfilled circle (i.e., dot sequence) or an underlined space (i.e., animal sequence) to indicate a missing item, for example, frog, frog, cow, frog, frog, cow, frog, frog. Three choices were presented at the bottom of the page within a black box. One of the choices was the missing last item from the array (e.g., cow). The children were asked to point to the missing picture, the one that comes next. The testers named all the items in each array, sometimes with the children spontaneously naming them along with the tester, and at the last one, the missing one, the tester gasped and said, “Something is missing. Which comes next (while pointing to the choice array)? Point to the one that is missing.” The dependent measure was the percentage correct out of six.

 Oppositional concepts task. For this task, one component of three oppositional concepts (i.e., empty/full, top/bottom, inside/outside) was represented in each of six pictures. Each of the six was shown to the child who was asked, for example, “Is the wagon empty or full?” The same probe was given once to the picture of an empty wagon and again later to the picture of a full wagon. Conceptually appropriate probes were presented for the other two concepts. The dependent measure was the percentage correct out of six.

 Taxonomic generation task. There were two categories: body parts and clothing. The testers named the exemplars and asked the children to name more. A maximum of two responses for each of the two categories was imposed and the maximum score attainable was four. If the children merely pointed to a body part or piece of clothing, only 1/2 point was awarded rather than a full point. The dependent measure was the total number of correct category exemplars generated divided by four.

 Semantic information task. This was another task that only used two pages. On one was an array of 12 cats and on the other, an array of fruit (e.g., pineapple, watermelon, orange). There were two probes for each set of items. For the cat page, the children were first asked to name the items (cats) and then were asked, “What do they look like?” The testers gave one example (i.e., “They have tails.”). Up to two responses were recorded and scored. For the second probe, the children were asked to tell what cats do. Again an example was provided (i.e., “They sometimes chase mice.”). Up to two responses were recorded and scored. The maximum number of points for the cat page was four. For the fruit page, probes were, “What can you do with fruit?” and “Where does fruit come from? Where go you get fruit?” No examples were provided for this second array. As before, two responses were scored. The maximum score for the fruit page was also four. The dependent measure was the total number of correct descriptions generated divided by eight.

 Word meaning task. Children were asked to tell the tester about an airplane. There were two specific probes (i.e., “What does an airplane do?” and “What does an airplane look like?”). Only the first two responses to each probe were scored. The dependent measure was the total number of descriptions generated divided by four.

 All of the children were tested in English except for four White/Hispanic children who were tested in Spanish based on teacher nomination, tester/child discourse, and performance on six simple questions to determine children’s understanding of a specific language. Responses in either English or Spanish were accepted. A tester who was fluent in both English and Spanish administered the battery in Spanish. Greater details for this study regarding sample, procedures and tasks can be found in Deuel (1997).

 Results

 Correlation of Tasks with IQ

 For this analysis, both children with MMR and children with LD were included. Using this total sample of LD and MMR children with IQ scores (N = 82), the range of IQ scores was 42-146 with a mean of 90 (SD = 22). Correlations between IQ and the tasks for this sample were as follows: size (r = .52), oddity (r = .29), sequencing (r = .29), oppositional concepts (r = .47), rhyme (r = .23), phonological awareness (r = .26), pointing (r = .36), taxonomic generation (r = .45), semantic information (r = .44), and word meaning (r = .47). All correlations were significant at p < .05. Interestingly, those tasks requiring either conceptual knowledge (taxonomic generation, semantic information and word meaning) or knowledge of specific concepts such as size

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and oppositional concepts (e.g., big vs. little, in vs. out) had the highest correlations with IQ, potentially reflecting underlying verbal skills. Overall, however, these correlations were relatively low, with an average correlation of .38, suggesting that these tasks are measuring cognitive processes that do not greatly overlap with IQ.

Cluster Analysis

To examine the potential clusters of cognitive performance in children with MMR, we employed a hierarchical cluster analysis procedure. Hierarchical methods initially assume that each entity is a cluster, and using some algorithm, combine clusters until all entities have been combined into one cluster. To conduct this analysis, standardized scores were computed for each dependent measure.

To measure dissimilarity among cases, the squared Euclidean distance was used. This distance measure derives values reflecting the sums of squared differences between variables for each pair for all pairwise comparisons. For combining clusters, Ward’s method was employed which combines clusters that will result in the smallest increase in the sums of squares at each step.

Unfortunately, there is no agreement among statisticians and researchers on the best way to determine the number of clusters to interpret (Gore, 2000). Stopping rules are statistically complicated and are not readily available in commonly used statistical software. Because of this, many researchers rely on their inspection of coefficients values (e.g., squared Euclidean distance between the two entities being joined) in the agglomeration schedule. Researchers consider the points at which a “jump” is present in the coefficient values as a signal that heterogeneous clusters are being combined. For the present cluster analysis, examination of the coefficients revealed that a five-cluster solution was appropriate (see Table 1). A five-cluster solution resulted in a cluster containing only one case, therefore, it was decided that a four-cluster solution would be more appropriate than the five-cluster solution.

Patterns of performance on the 10 tasks are displayed for four clusters in Figure 1. In addition, Table 2 presents the mean percent correct scores and SDs for each task for each of the four clusters. With these data, we can begin to discuss the cognitive profiles of the children within the four clusters.

Cluster 1. This group contained six children. In general, the performance of these children was good across all tasks compared to their peers with MMR. In particular, these children performed well on those tasks that made up the verbal factor; relative size, taxonomic generation, semantic information, and word meaning. Data presented in Table 2 indicate that the children in Cluster 1 performed better than their peers with MMR on the relative size task, taxonomic generation task, semantic information task and the word meaning task. For the tasks that required a verbal response, children in Cluster 1 were able to generate correct verbal information whereas children in the other three clusters rarely responded correctly.

Cluster 2. This cluster contained six children. In contrast to the children in Cluster 1, children in Cluster 2 performed poorly on the verbal tasks. However, children in this cluster demonstrated similar performance to the children in Cluster 1 on the perceptual and phonemic awareness tasks such as oddity, oppositional concepts, sequence, pointing, phonological awareness and rhyme. Performance of the children in Cluster 2 indicated a weakness in those tasks related to verbal ability.

Cluster 3. This cluster contained six children. Children in Cluster 3 also performed poorly on the verbal tasks similar to the children in Cluster 2. In addition, their performance levels on the perceptual tasks were somewhat lower than the performance of children in Clusters 1 and 2. The most striking

<table>
<thead>
<tr>
<th>Number of Clusters</th>
<th>Coefficient</th>
<th>Percent change in coefficient to next level</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>66.469</td>
<td>14.10%</td>
</tr>
<tr>
<td>6</td>
<td>75.838</td>
<td>13.81%</td>
</tr>
<tr>
<td>5</td>
<td>86.308</td>
<td>19.38%</td>
</tr>
<tr>
<td>4</td>
<td>103.031</td>
<td>21.78%</td>
</tr>
<tr>
<td>3</td>
<td>125.469</td>
<td>24.58%</td>
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<tr>
<td>2</td>
<td>156.308</td>
<td>66.34%</td>
</tr>
<tr>
<td>1</td>
<td>260.000</td>
<td></td>
</tr>
</tbody>
</table>
Figure 1. Mean z score on each of the 10 tasks for Clusters 1 through 4.
part of their profile however was the poor level of performance on the phonological awareness tasks; phonological awareness and rhyme.

Cluster 4. There were nine children in Cluster 4. These children performed poorly on the verbal tasks like the children in Clusters 2 and 3, and poorly on the perceptual tasks like the children in Cluster 3. However, children in Cluster 4 performed more like the children in Clusters 1 and 2 on the phonological awareness tasks.

Cognitive Profiles, IQ scores and Age

Mean IQ scores and SDs for each cluster are presented in Table 3. To determine if there were differences in the IQ scores for the groups formed for each cluster, one-way analysis of variance (ANOVA) was conducted with IQ scores as the dependent variable and cluster as the independent variable. This analysis revealed that there were no significant differences between the IQ scores among the four clusters, $F(3,19) = .67, p = .58$.

Mean ages in months and SDs for each cluster are presented in Table 4. Again, an ANOVA was conducted with age in months as the dependent variable and cluster as the independent variable. This analysis revealed that there were significant differences between the mean age in months among the four clusters, $F(3,23) = 3.94, p < .05$. Post hoc comparisons using the Bonferroni method revealed a significant difference between the mean age of children in Cluster 1 ($M = 73.3$) and the children in Cluster 3 ($M = 60.2$).

To examine these variables further, a mean total score was calculated for each child by obtaining the mean of the percent correct score across the 10 tasks. Correlations were computed between this measure of mean total score and IQ scores and age in months.

### TABLE 2

<table>
<thead>
<tr>
<th>Clusters</th>
<th>1 (n = 6)</th>
<th>2 (n = 6)</th>
<th>3 (n = 6)</th>
<th>4 (n = 9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive tasks</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Relative Size</td>
<td>.86 (.16)</td>
<td>.47 (.13)</td>
<td>.36 (.07)</td>
<td>.35 (.13)</td>
</tr>
<tr>
<td>Taxonomic Gen.</td>
<td>.71 (.37)</td>
<td>.00 (.00)</td>
<td>.04 (.10)</td>
<td>.07 (.09)</td>
</tr>
<tr>
<td>Semantic Info.</td>
<td>.77 (.18)</td>
<td>.15 (.12)</td>
<td>.08 (.13)</td>
<td>.13 (.17)</td>
</tr>
<tr>
<td>Word Meaning</td>
<td>.71 (.25)</td>
<td>.08 (.13)</td>
<td>.00 (.00)</td>
<td>.03 (.08)</td>
</tr>
<tr>
<td>Oddity</td>
<td>.64 (.34)</td>
<td>.50 (.15)</td>
<td>.22 (.20)</td>
<td>.31 (.15)</td>
</tr>
<tr>
<td>Sequence</td>
<td>.39 (.31)</td>
<td>.36 (.19)</td>
<td>.14 (.13)</td>
<td>.26 (.19)</td>
</tr>
<tr>
<td>Oppositional Task</td>
<td>.72 (.20)</td>
<td>.53 (.19)</td>
<td>.42 (.33)</td>
<td>.04 (.11)</td>
</tr>
<tr>
<td>Pointing</td>
<td>.47 (.17)</td>
<td>.50 (.20)</td>
<td>.06 (.09)</td>
<td>.05 (.07)</td>
</tr>
<tr>
<td>Rhyme</td>
<td>.58 (.09)</td>
<td>.58 (.14)</td>
<td>.14 (.16)</td>
<td>.56 (.25)</td>
</tr>
<tr>
<td>Phonological Task</td>
<td>.61 (.20)</td>
<td>.64 (.25)</td>
<td>.17 (.15)</td>
<td>.52 (.21)</td>
</tr>
</tbody>
</table>

**Note.** SDs in parentheses.

### TABLE 4

<table>
<thead>
<tr>
<th>Mean Age and Range for Each of the Four Clusters</th>
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<tbody>
<tr>
<td>Cluster</td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
</tbody>
</table>

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months had a significant correlation with mean total score \((r = .70, p < .001)\) whereas IQ score did not \((r = .22, p = .31)\). Thus, age in months, and not IQ score, was associated with higher performance levels on the cognitive tasks.

**Discussion**

The present study represents an exploratory analysis of individual differences in the cognitive performance of children with MMR. Our aim was to provide preliminary data that focused on individual differences in the cognitive profiles of children with MMR and to emphasize the need for such analyses in future research. Tasks were developed specifically to have high face validity as indicators of subsequent cognitive performance. Scott and Delgado (2002) reported that, in a large sample, preschool children’s performance on cognitive tasks similar to those used in the current study were predictive of their later educational status and academic difficulties (e.g., low achievement test scores) in third grade. Cognitive tasks used in the present study had moderate to low correlations with IQ scores. Thus, the cognitive tasks used in the present study were appropriate for examining cognitive abilities within a heterogeneous IQ group (Detterman et al., 1992).

Using this variety of cognitive tasks, specific patterns of performance were observed for each cluster, suggesting differences in strengths and weaknesses in the cognition of differential groups of children with MMR. Children in Cluster 1 appeared to perform at higher levels on the verbal tasks compared to the children in the other clusters. Children in Cluster 3 appeared to perform more poorly on the tasks requiring phonological awareness than the children in Clusters 1, 2 and 4. It is important to emphasize, however, the exploratory and very preliminary nature of our findings. The small sample size precludes the use of inferential statistics. We cannot be certain the observed profiles represent distinct distributions of cognitive abilities among the population of children with MMR. Along with many in the behavioral sciences, however, we caution against an over reliance on statistical significance as the yardstick by which empirical contributions are judged (Cohen, 1990).

The value of our analysis resides in its conceptualization and approach to a very important area of work in the field of mental retardation research. Our data suggest but do not confirm the presence of distinct patterns of cognitive abilities in young children with MMR. Due to the small sample size, we can make no claims as to the reliability of our cluster solution or to the differentiation of the specific cognitive abilities examined. It is possible that we have captured normally occurring variation in our analysis but the systematic pattern of our data suggests to us that we would obtain a similar result with a larger sample.

Although we can make no practical recommendations based on these findings, we strongly urge further work on this important topic. Researchers have begun to call for the examination of cognitive differences between and within individuals with different genetic syndromes associated with MMR (Dykens, 2001). Unfortunately, one limitation of the current study is the lack of information about our participant’s etiology, although the majority of our sample had mental retardation related to cultural/familial causes. Ongoing investigation of the cognitive ability profiles of individuals with MMR can enhance educational practice and the individualization of educational plans for young children with MMR. Our data indicate no relation between performance on the cognitive tasks and children’s IQ scores. That is, children with higher IQ scores were not the same children that scored at high levels on the cognitive tasks. According to Detterman et al. (1992), a single IQ score provides little information about the cognitive abilities of individuals with MMR, but rather more specific information about the basic cognitive processing associated with low IQ is needed. Our results specifically illustrate this point. In special education, instruction must be individualized for each child. The specific patterns of cognitive performance demonstrated by different groups of children with MMR indicate that while these children are similar in their IQ scores, they have different strengths and weaknesses that may inform instructional practice. To reach this goal, much more information is needed describing the cognitive capabilities of individuals with MMR with respect to each other, as opposed to individuals without MMR.
An additional important goal for future work in this area will be to examine cognitive ability profiles of children with LD and the extent to which young children with LD are distinct from or similar to individuals with MMR as assessed by the type of practical cognitive tasks employed by our battery. Although we did not examine these questions within this analysis, this is clearly an important area for future work and one that we hope will be stimulated by and benefit from the type of analysis presented here.

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