A Sensorimotor Program for Improving Writing Readiness Skills in Elementary-Age Children

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This article discusses a writing readiness program used with three groups of children aged 5 to 7 years. The program combines occupational therapy treatment with a supplementary program implemented by school personnel or parents. The Developmental Test of Visual-Motor Integration—Revised (Beery, 1982) was used to measure the developmental level of the children's writing readiness skills before and after treatment. The group of children with a significant verbal performance IQ discrepancy (> 15 points) showed a 17-month growth in readiness skills within 1 year. The group of children with mental retardation (IQ < 80) showed a significant sex effect: The boys showed more gains than the girls. Implications of these findings are discussed.

The delayed development of fine motor skills in young children is a frequent cause of referral to school-based occupational therapists. Developmental delay in kindergarten and first-grade children often manifests itself as incomplete mastery of the readiness skills needed to print. Upon meeting a child referred for treatment, the therapist determines if there is a sensorimotor cause for the developmental delay and, if so, provides direct intervention or consultation services to remediate the problem.

Literature Review

Delay in writing readiness skills has been addressed by several authors. Ajuriaguerra and Auzias (1975) stated that the motor aspect of writing starts with scribbling. Over time, the scribbling becomes intentional. Eventually, the child learns to combine elementary design patterns into precise shapes. Beery (1982) suggested that the mastery of the first nine figures in his Developmental Test of Visual-Motor Integration is essential for learning to print. This test was designed to assess the perceptual-motor development of children aged 3 to 14 years. The first nine figures in the assessment are (a) a vertical line, (b) a horizontal line, (c) a circle, (d) a crossed t, (e) a right-to-left diagonal, (f) a left-to-right diagonal, (g) an x, (h) a square, and (i) a triangle. In another study, Nihei (1983) looked at the progressive steps in the drawing and handwriting of Japanese preschoolers. His study lends support to the developmental trend that underlies the elementary drawings in the Developmental Test of Visual-Motor Integration. Alston and Taylor (1987) used a developmental model to examine handwriting and emphasized the importance of the mastery of writing readiness skills before letter formation is attempted.

The perceptual-motor development necessary for the mastery of writing is fairly complex. Perceptual-motor skills can be thought of as a composite of perceptual, conceptual, and motor processes or any combination of these three processes (Mattison, McIntyre, Brown, & Murray, 1986). It is commonly believed that children with learning or neurological disabilities often have an irregular academic readiness profile with a delay of one or more of the perceptual-motor skill components. Mattison et al. (1986) analyzed the visuomotor problems of children with learning disabilities and found that they had significantly more trouble than normal children with design-copy tasks with simultaneous visuomotor components. They concluded that a “cross-modal” or intersensory integration function was defective. Other authors found similar results, thus indicating that the weakest skill in the total composite is the motor coordination component. Lewis and Lewis (1965) analyzed the kinds of
errors first-grade children made while forming manuscript letters. The three most common errors—incorrect size, incorrect relationship of parts, and incorrect placement relative to size—were related to lack of motor control. Examining the printing errors made by kindergarten students copying letters, Simner (1982) found more form errors, that is, more motor coordination errors, than reversals.

Training directed at any one of the perceptual-motor skill components tends to enhance the overall performance. Strayer and Ames (1972) found that the ability to copy designs improved after a brief period of visual-perceptual training that emphasized the orientation of figures. Jennings (1974) showed a positive and significant relationship between the ability to manipulate objects and the ability to copy designs. Laszlo and Bairstow (1983, 1984) found long-term benefits after using a kinesthetic and sensitivity training program with 7- and 8-year-old children. They recommended activities to generate kinesthetic awareness, such as large arm movements at the blackboard or easel. Stott, Henderson, and Moyes (1987), in their remedial handwriting program, recommended the development of a motor schema. They emphasized large movement patterns along with a smooth, fluid motion. Furner (1967) developed a classroom handwriting program that stressed verbalization and perceptual processes. She found that if faulty habits were allowed to develop, good patterns would then be harder to establish. She emphasized the need for handwriting programs with perceptual-process training.

Occupational therapists can treat perceptual problems in various ways, ranging from consultation to direct intervention (Gilfoyle & Hays, 1979). Direct therapy's benefits are enhanced markedly if school personnel and parents participate in the remediation process (Friedman, 1982; Gilfoyle & Hays, 1979; Goldstein, O'Brien, & Katz, 1981). The importance of family involvement has been emphasized with the passage of the Education of the Handicapped Act Amendments of 1986 (Public Law 99-457), which measure fine motor control and a supplementary program and (b) the child's developmental delay in writing readiness skills was at

Pilot Project for Writing Readiness Skills

Participants

The pilot project involved three groups of children. Group 1 consisted of 12 children (9 boys and 3 girls) of normal intelligence (mean IQ = 94), as defined by a full scale IQ greater than 80 and a performance IQ greater than 80 on the Wechsler Intelligence Scale for Children—Revised (Wechsler, 1974). All of these children were in regular education classes. One child in this group was black and the other 11 children were white, as were all of the other children included in the project. The mean age of this group was 72 months.

Group 2 consisted of 6 children (4 boys and 2 girls), all of whom had a significant disparity between verbal IQ and performance IQ (>15 points) on the Wechsler Intelligence Scale for Children—Revised. The mean IQ was 77, but their average verbal IQ was 86 and their average performance IQ was 71. At the time of the study, 2 of these children were in regular education classes with no special education support besides occupational therapy, 3 children were in a regular class with additional time in a class for children with learning disabilities, and 1 child was in a class for children with educable mental retardation. The mean age of this group was 67 months.

Group 3 consisted of 6 children (2 boys and 4 girls). Five of these children were in special education classes. The only child in regular education had a supportive home environment and was labeled an overachiever. Most of the students in this group had conditions that were diagnosed as mental retardation of unknown etiology. One student had a hearing impairment and another student was autistic. This group's mean IQ was 65, and the mean age was 75 months.

All 24 children included in this project had delayed writing readiness skills and were unable to learn these skills in a typical classroom environment. None of the children had mastered all nine of the elementary designs on the Developmental Test of Visual-Motor Integration. All of the children showed comparable delays on the fine motor subtests of the Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978), the Peabody Developmental Motor Scales—Fine Motor Scale (Folio & Fewell, 1983), the Miller Assessment for Preschoolers (Miller, 1988), and the Motor-Free Visual Perception Test (Colarusso & Hammill, 1972), which measure fine motor control and visual-perception skills. All of the 5- to 6-year-old children who had been referred to me over a 6-year period were included in the program if they met the following criteria: (a) the severity of the problems exhibited by each child warranted both direct therapy and a supplementary program and (b) the child's developmental delay in writing readiness skills was at
least 1 year or more when compared to chronological age. Six of the 12 children in Group 1 were delayed more than 1½ years; the remainder were delayed 1 to 1½ years. Group 2 had 1 child delayed 1 year and 5 children delayed more than 1½ years. Group 3 had 1 child delayed 1½ years and 5 children delayed more than 1½ years.

Children who were initially referred but who later moved, who were delayed less than 1 year, or who did not experience both direct therapy and the supplementary program were not included in this study.

Treatment
As part of the diagnostic process, the Developmental Test of Visual-Motor Integration was used to determine the developmental level of each child's writing readiness skills. I administered and scored the test according to the test directions. The test was readministered after 1 year. The change in each child's writing readiness developmental level was used to evaluate his or her progress.

The therapy program used with these students had two parts, which were administered concurrently. One part of the intervention involved direct therapy, in which I, the occupational therapist, saw each child individually once a week for 30 minutes. In a few situations, because of time constraints or better performances, I saw the children in pairs. Activities during therapy focused on writing readiness skills and included multisensory stimulation and large movement patterns. Therapy activities were directed at increasing the child's attention to lines and elementary designs. The child was asked to copy simple design elements using a variety of media including paper strips, masking tape on the floor, chalk of various colors and sizes, clay, or a finger trail on the blackboard or in sand. Children who were slow to respond were given a 1-lb wrist weight to wear intermittently on the dominant forearm to facilitate sensory proprioceptors. As the child progressed, the elementary designs used during therapy became more complex and the therapy activities eventually approximated manuscript letters. To vary the sensory stimulation and to heighten interest and responsiveness, the therapist used other readiness activities during the therapy sessions, including bead stringing, block design, parquetry, and paper folding. All of the therapy activities were designed to increase attention to detail and lines and to improve control of the fingers and of the writing instrument. The therapist's role was to strengthen the child's readiness skills. Letter formation was taught by both the classroom teacher and the adult using the supplementary program.

The second part of the intervention involved a supplementary program that complemented the direct therapy. A classroom teacher, classroom aide, or parent, using the program outlined by the occupational therapist, worked with the child a minimum of three times a week for 10 minutes at a time. The adult was given a structured format to follow, and each session consisted of the following activities:

1. **Warm-up activities.** These consisted of elementary designs, well below the child's readiness level, drawn on the blackboard and on paper (e.g., making railroad tracks by filling in vertical lines between two horizontal lines).

2. **Structured work sheets from the Dubnoff School's program of sequential perceptual-motor exercises** (Dubnoff, Chambers, & Schaefer, 1968). Each work sheet contained a series of simple mazes on which the child drew a line that matched the original as closely as possible. The difficulty level was increased very gradually. The mazes started with single vertical and horizontal lines, which eventually were combined into letter forms. To reduce the cost of materials, a plastic template was used over each sheet, and the child used a grease pencil on the template.

3. **Manuscript letter practice.** In the last part of each session, the child, working at his or her developmental level, made capital manuscript letters on the blackboard. The straight-line letters were mastered first, followed by the letters with diagonal elements, and finally the curved letters. Whatever the child did on the blackboard, he or she then repeated on paper using a grease pencil.

The emphasis of the supplementary daily program was a sufficiently slow pace so that the child would succeed every day. The parent or aide usually reported that the child was delighted and proud of the ability to do the work. As the child's confidence grew, the pace quickened. At least once a month, the therapist met with the adult to ensure the appropriateness of the program and the pace.

Typically, the supplementary program continued for 5 to 8 months. Thereafter, the child usually had either progressed sufficiently or was less motivated, in which case the program was used less frequently (i.e., once or twice a week). When school resumed in the fall, direct therapy was discontinued if the student was able to do the written assignments without excessive frustration. Otherwise, therapy was continued. After 1 year, follow-up testing was done.

Results
All 12 of the children in Group 1 mastered the nine writing readiness designs on the Developmental Test...
of Visual-Motor Integration within 1 year. Four children in Group 2 and 4 children in Group 3 mastered all nine designs. The remaining 2 children in Group 2 mastered eight of the nine designs and could occasionally make a triangle. The remaining 2 children in Group 3 were able to make vertical and horizontal lines singly and in combination but were still unable to draw diagonal lines.

The largest gain in developmental skill level was made by Group 2—a gain of 17 months with a range of 14 to 22 months (see Table 1 for a summary of performance scores).

The sensorimotor writing readiness program was more successful with the special education students in Group 3 than with average-IQ students in Group 1, but the gain was not significantly different from the expected normal maturation. The average gain for Group 3 was 12 months with a range of 2 to 22 months. The average gain for Group 1 was 9.5 months with a range of 3 to 18 months.

The sex effect was not significant for Group 1. The sex effect was significant, however, for Groups 2 and 3. Both of these groups had below-average IQ scores (<80). The combined group of boys from Groups 2 and 3 (n = 6) had an average gain of 17 months, which was significantly greater than the gain expected from maturation alone. The girls from Groups 2 and 3 (n = 6) had an average gain of 11.83 months.

**Discussion**

The results of this program indicate that special populations who have deficits in their writing readiness skills will benefit from individualized instruction that emphasizes multisensory training. This particular method of improving writing readiness skills is especially helpful with those children who have a difference of 15 points or more between their verbal and performance IQ scores on the Wechsler Intelligence Scale for Children—Revised. Children with this IQ profile should therefore be given priority for therapy intervention. Often, this type of child becomes frustrated with the “seatwork” commonly done in the kindergarten or first-grade classroom and experiences few successful readiness activities. The 12-month average gain made by the children with mental retardation in Group 3 is also significant. When the demand for services exceeds the availability of therapists, such services should be made available to those children most likely to benefit.

The difference in net gain made by the girls and boys in Groups 2 and 3 is surprising. Typically, girls do better than boys on paper-and-pencil activities. Judd, Siders, Siders, & Atkins (1986) examined sex-related differences of first graders on a design copy activity and a dotting circle activity. The girls did significantly better on the design copy activity, but no difference was found between the groups on the dotting circle activity. Perhaps the girls in this study showed less improvement because they had primary or more severe perceptual-motor deficits, rather than just delayed development.

Overall, the children in Groups 1 and 3 were closer in age than were those in Group 2. Group 2’s mean age was 5 months younger than Group 1’s mean age and 8 months younger than Group 3’s mean age. The oldest child in Group 2 was almost 1 year younger than the oldest child in either of the other two groups. However, the children in Group 2 made the most progress. This suggests that there is an optimal time for remediating delayed readiness skills. The older children in Groups 1 and 3 may have become habituated to failure with pencil skills and, as Furner (1967) indicated, more resistive to change.

Contrary to my expectations, the regular education students in Group 1 made the least progress (see Table 1). The reasons for this are unclear. The pretest level of readiness skills was more advanced for this group as compared with the other two groups. Initially, this group on the average could make six of the nine designs on the Developmental Test of Visual-Motor Integration, whereas the other two groups could make only four or five designs. Perhaps once the readiness skills were mastered, the Developmental Test of Visual-Motor Integration was no longer a sensitive measure of progress; the value of this test to measure functional paper-and-pencil skills beyond the readiness level needs to be examined. This project, however, demonstrates the usefulness of the Developmental Test of Visual-Motor Integration to assess paper-and-pencil and fine motor skills of preschool- and early-elementary-age children. The test is administered easily and quickly, and previous studies indicate a high test–retest reliability (Breen, Carlson, & Lehman, 1985; Klein, 1978; Ryckman & Rentfrow, 1971). Its ease in administration makes it a particularly valuable tool for the measurement of writing readiness skills.

One of the unique elements of the writing readiness program is its combination of direct therapy with an ongoing classroom-oriented remedial program. With the involvement of teachers, aides, and parents,

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**Table 1**

Mean Performance Scores of Elementary-Age Children on the Developmental Test of Visual-Motor Integration

<table>
<thead>
<tr>
<th>Group</th>
<th>Initial Score (in months)</th>
<th>Retest Score (in months)</th>
<th>Gain</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>55.2</td>
<td>64.7</td>
<td>9.5</td>
<td>4.61</td>
</tr>
<tr>
<td>2</td>
<td>45.6</td>
<td>63.0</td>
<td>17.0</td>
<td>3.44</td>
</tr>
<tr>
<td>3</td>
<td>48.0</td>
<td>60.0</td>
<td>12.0</td>
<td>7.15</td>
</tr>
</tbody>
</table>

* (Beery, 1982)
the new skills that the child learns in therapy can be reinforced through practice. Additionally, motivation and enthusiasm seem to be heightened when a teacher, a parent, or both share in the responsibility for a child's progress. Certainly, recognition of the benefits of a team effort is emphasized in Public Law 99–457.

Another feature of this program is the structured format of the supplementary program. The parents and school personnel favorably noted the ease with which they could follow the directions and use the materials. Additionally, because the work sheet packets were prearranged, the therapist did not need to devote time to finding new materials for each child.

This project poses many questions. Which method of intervention is the most effective—direct therapy or a supplementary program? Or were the gains evident in this program attributable to the combination of the two methods? A research model could be used to examine the treatment effect through a comparison of a control group and three experimental groups, each receiving a different treatment.

Other components of this training program are untested and need to be challenged. I believe that the use of a resistive writing instrument (e.g., a grease pencil) provides increased sensory feedback to the student and is therefore conducive to optimal learning. Further testing is needed to confirm this hypothesis. The use of wrist weights to promote increased control of a writing instrument also needs further examination. In addition, although the Dubnoff School materials are no longer available commercially, other similar materials are available, such as Burke and Burke's (1980) Sensory-Motor Writing Program and Zaner-Bloser's (1982) handwriting method. Many of these programs are reviewed in an article by Loikith and Rutter (1989). Further clinical studies are needed to ascertain their benefits.

Finally, occupational therapy intervention techniques that deal with the other motor components of writing readiness, such as sitting posture, trunk and shoulder stability, pencil grip, and handedness, need to be examined. Evaluation tools, test instruments, and treatment methods are all important areas for research.

Acknowledgment

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