A Short-Term Graphomotor Program for Improving Writing Readiness Skills of First-Grade Students

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KEY WORDS
- Arab
- graphomotor skills
- handwriting
- Jewish
- pediatrics
- school-based occupational therapy

OBJECTIVE. Children with fine-motor problems and handwriting difficulties often are referred for occupational therapy. The objective of this study was to test the efficacy of a short-term treatment on the fine-motor and graphomotor skills of first-grade students.

METHOD. We recruited 52 first-grade students who had scored below the 21st percentile on the Visual–Motor Integration test from schools in a city with a low socioeconomic, mixed (Arab and Jewish) population. The children were randomly divided into an intervention group and a control group. Before and after the intervention, we administered two tests to both groups.

RESULTS. Students in the intervention group made significant gains both in the total score on the graphomotor test (Developmental Test of Visual Perception) and on the fine-motor test (Bruininks–Oseretsky Motor Development Scale).

CONCLUSION. This study provided preliminary evidence of the efficacy of a short-term graphomotor intervention. The results increased the feasibility of implementing occupational therapy intervention in the Israeli school system, allowing treatment of more children using the same resources.

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Observation of daily activities in regular elementary school classrooms has revealed that between 30% and 60% of the school day is devoted to fine-motor activities, such as cutting and coloring, and especially to writing tasks, which predominate over other manipulative tasks (Linder, 1986; McHale & Cermak, 1992). Most children ages 6 to 7 years are mature enough to be able to carry out these assignments (McHale & Cermak, 1992; Weil & Cunningham Amundson, 1994). Nevertheless, 10% to 20% of students experience visual–motor delay to various degrees (Hamstra-Bletz & Blote, 1993; McHale & Cermak, 1992; Schneck, 1991). Visual–motor problems may interfere with the child's ability to acquire writing skills and to fully participate in student activities.

Because of the negative effects of handwriting difficulties on a child's academic performance and self-esteem (Margalit, 1998; Pavri & Monda-Amaya, 2000), early evaluation and treatment of visual–motor problems among first-grade students are of major importance. Moreover, the disparity between children with visual–motor difficulties who are not treated and their classmates tends to remain constant as the children age (Marr & Cermak, 2001). Reducing the disparity in first grade is crucial; research has shown that healthy adjustment during the first years of school is a precursor of subsequent school success and that individual differences in children's school results remain relatively stable after the first few years in school (e.g., Alexander, Entwisle, & Olson, 2001).

First-grade students' handwriting cannot as yet be assessed in Israel. Handwriting skills in Hebrew cannot be evaluated until the second school year, when children have acquired efficient writing skills (Lifshitz & Parush, 1999). The lack of valid assessment procedures for first graders limits the ability of Israeli professionals to accurately assess children's prewriting skills, which are necessary for participation in first grade. This constraint dictates having to assess the child's performance capacity related to handwriting. Many researchers consider assessing the child's graphomotor skills to be an acceptable parameter for evaluating writing readiness (Beery, 1997; Daly, Kelley, & Krauss, 2003; Laszlo & Broderick, 1991). Visual–motor skill is an important component of success in writing. Individual differences in visual–motor integration are significantly related to academic performance and social competence in young children (Schoemaker & Kalverboer, 1994; Taylor, 1999).

Specific links also have been found between visual–motor integration and writing quality (e.g., Levine, 1987; Tseng & Chow, 2000) and between kinesthesia and handwriting development (Lazlo & Bairstow, 1984). Therefore, early identification of handwriting or graphomotor integration problems and subsequent adequate intervention may decrease the child's difficulties. Indeed, occupational therapy intervention has been found to improve visual–motor skills in preschool children and children in their first years of school (Dankert, Davis, & Gavin, 2003; Oliver, 1990; Parush & Hahn-Markowitz, 1997). Nevertheless, even when there is evidence of a treatment's effectiveness, economic and organizational factors place external parameters on occupational therapists' abilities to incorporate evidence into their practices (Rappolt, 2003). For these reasons, occupational therapists in school settings primarily treat children with severe impairments, whereas children with mild impairments do not receive the help they need (Reisman, 1991).

In the present study, we attempted to incorporate practice demands into the study design, which adapted the current approach among health professionals to shorten treatment (Valmaggia, Van der Gaag, Tarrier, Pijnenborg, & Slooff, 2005) to make interventions effective and economic. The objective of the study was to assess the efficacy of a short-term intervention on visual–motor skills in first-grade students from low socioeconomic backgrounds. Specifically, we hypothesized that the visual–motor scores of the children in the treatment group would be higher after the intervention than the scores of children in the control group.

Method

Participants

The study participants were first graders from four elementary schools in Jaffa, Israel. The schools met the following criteria: (a) an occupational therapist was on staff at the school, (b) the school provided an occupational therapy room, and (c) the school made an unambiguous commitment to allow us to carry out the study. Students attending these schools came from a low socioeconomic, mixed Arab and Jewish population.

All first-grade students attending the schools (198 children) were administered the Beery–Buktenica Developmental Test of Visual–Motor Integration (VMI; Beery, 1997). Low scores indicate poor visual–motor skills, and study participants who scored lowest on the VMI test were selected. Scores of 25% to 75% are considered average (Beery, 1997); a score of 21% or lower was the cutoff point for this study. Seventy-one children (36%) scored under the cutoff point.

Seven exclusion criteria were applied to participants:

1. A medical diagnosis indicating a central nervous system dysfunction such as mental retardation, cerebral palsy, or autism (0 children excluded);
2. Severe sensory loss (i.e., visual or auditory impairment; 0 children excluded),
3. Indication of emotional, behavioral, or mental problems as reported by the teachers (10 children excluded),
4. Participation in the special education program with part-time inclusion in regular classes (2 children excluded),
5. Participation in intervention by an occupational therapy or physiotherapy professional (0 children excluded),
6. Withholding of consent by parents (0 children excluded), and
7. Failure to complete the study program because of repeated absence from school (7 children excluded).

Fifty-nine children meeting the criteria were randomly divided into the treatment and the control groups. During the study, 3 children from the control group and 4 from the treatment group dropped out because of Criterion 7. There were 24 participants in the treatment group (13 boys, 11 girls) and 28 participants in the control group (12 boys, 16 girls). The ratios of boys to girls were similar in both groups ($\chi^2[1, N = 52] = 0.66, p =$ ns).

Measures

Visual–Motor Integration Test. The Beery–Buktenica Developmental Test of Visual–Motor Integration (Beery, 1997) is a developmental sequence of geometric forms to be copied with paper and pencil. The school occupational therapist administered all 27 items by group procedure in the classroom in about 10 to 15 min. The test is reliable and valid (Beery, 1997) and commonly is used for screening purposes. In our participants' schools, the school occupational therapist uses this test (with parental consent) at the beginning of each year to screen first graders. It was thus administered as a regular classroom procedure.

Developmental Test of Visual Perception. The Developmental Test of Visual Perception (DTVP–2; Hammill, Pearson, & Voress, 1993) includes eight subtests; we administered only four that measure visual–motor performance: eye–hand coordination, copying, spatial relationships, and visual–motor speed, all motor-related measures. The norms for the DTVP–2 were developed using a sample of 1,972 children 4 to 10 years old. Test–retest reliability for the DTVP–2 (n = 88) ranged from r = .71 to r = .86 and was r = .96 for the total score. Interrater reliability (n = 88) was r = .98 for the total test (Hammill et al., 1993). One of the authors administered the test before and after the intervention, and scoring was completed by an occupational therapist who was not familiar with the study groups or the hypothesis.

Bruininks–Oseretsky Motor Development Scale. The Motor Development Scale of the Bruininks–Oseretsky Test of Motor Proficiency (Bruininks, 1978) was designed to assess children's motor development and to measure their gross- and fine-motor skills. This study used only a summary score of Subtest 8 from the fine-motor scale, which includes evaluations of visual–motor control and finger coordination. An occupational therapist administered the test. Because of technical problems, only 15 of 24 children in the study group and 24 of 28 children in the control group were administered the Bruininks–Oseretsky test.

Graphomotor Intervention

The short-term intervention program we used, developed by Efraim (2002) as part of the requirements for her master's degree, encourages writing skills in first-grade children. The intervention is based on three lines of reasoning:

1. Motor learning theories, which hold that for a client to improve, the practiced tasks should be as similar as possible to the required assignment (Polatajko et al., 1995);
2. Multisensory theory (Lockhart & Law, 1994); and
3. Research that found associations between dexterity skills and normal development of visual–motor proficiency (Benbow, 1995; Cornhill & Case-Smith, 1996; Humphry, Jewell, & Rosenberg, 1995; Levine, Oberklaid, & Melzer, 1981).

The activities and tools chosen for this intervention program also were based on our clinical experience and Benbow's (1995) recommendations.

The intervention included 12 sessions, each held once a week for 45 min. The first 10 to 15 min of each session were dedicated to playful fine-motor activities and the remaining 30 to 35 min exclusively to pencil-and-paper activities. Fine-motor activity layouts included threading beads; inserting pegs; and undertaking guided play with coins, screws, screw nuts, and other items. The pencil-and-paper layouts included pattern molds for drawing and various worksheets with activities such as connecting numbers, dots, or arrows; coloring by numbers; and tracing mazes.

As part of their fieldwork, 10 occupational therapy students administered the intervention sessions to two students at a time in the school's occupational therapy room. All activity tools were prepared in advance in 12 kits, one for each week's session. An experienced pediatric occupational therapist supervised all occupational therapy students each week, guiding them in using the kit and analyzing the children's performance on the previous session.

Procedure

The office of the Israeli education ministry approved this study. All parents of the first-grade students signed consent forms for the VMI; the forms specified that if necessary, the study would include further evaluation (i.e., the DTVP–2 and Bruininks–Oseretsky test) and intervention.

Children who scored below the VMI cutoff point completed the DTVP–2 and the Bruininks–Oseretsky test before and after intervention. After the first evaluation, they participated in 12 intervention sessions.

Statistical Analysis

We used raw scores rather than standard scores or percentiles to compare mean scores (Wilson, Polatajko, Kaplan, & Faris, 1994) because of the 12-week difference between the pretest and posttest scores (the children's ages were matched between the two groups) and because, for Israel, it is more appropriate to use raw data than to transform the scores to U.S. norms. To ensure that this strategy was correct, we standardized the scores by calculating the difference between the results as percentages relative to each individual pretest score according to the following formula:

$$\frac{\text{Posttest score} - \text{Pretest score}}{\text{Pretest score}} \times 100$$

The differences between the study and the control groups were very small. Therefore, we used the raw scores.

We used one-way multiple analysis of variance (MANOVA) to determine group differences between study and control participants on four DTVP–2 pretest scales and the VMI. No significant differences were found between the groups on each of the measures (multivariate Wilks's $F[6, 45] = 0.97$, p = ns).

Because of missing data from the Bruininks–Oseretsky test, we analyzed the dependent variables (DTVP–2 and the

Bruininks–Oseretsky test) separately. To determine the effect of the intervention on the treatment group, we conducted repeated MANOVA measures (Time × Group × DTVP–2 measures) on four raw score measures from the DTVP–2 tests, and we conducted repeated ANOVA measures to compare the total DTVP–2 standard scores and Bruininks–Oseretsky raw test scores of the study and control groups.

Because the study population consisted of both Arab and Jewish children, we performed further analyses of demographic differences. We performed two- and three-way ANOVAs to measure the effect size of population group.

Results

We compared the groups by age ($t[50] = 0.58$, p = ns). The treatment group had a mean age of 80 months (SD = 4 months, range 72–88 months), and the control group had a mean age of 79 months (SD = 4 months, range 73–89 months). Both groups included Jewish and Arab participants (treatment group, 14 Arab participants; control group, 17 Arab participants; $\chi^2[1, N = 52] = 0.03$, p = ns).

Hypothesis Testing

Results indicated a significant interaction (Time × Group) in three of the four measures of the DTVP–2 (Table 1):

1. The eye–hand coordination measure showed significant improvement in the treatment group from a mean score of 135.0 to a mean score of 152.8, whereas control group mean scores improved from 143.6 to 149.3 ($F[1, 50] = 6.41$, $p < .02$).
2. Children in the treatment group improved their mean copying scores significantly more than the control children, from 16.0 to 19.6 ($F[1, 50] = 7.70$, $p < .01$); control children improved their performance only slightly, from a mean score of 16.6 to a mean score of 17.7.
3. A significant interaction effect ($F[1, 50] = 16.22$, $p < .001$) on the measure of spatial relations indicated the same pattern of improvement. Treatment group participants improved their mean score of 23.1 to a posttest mean of 35.8, whereas control children improved their mean scores from 24.3 to 29.1.

Repeated ANOVA measures comparing treatment and control groups' Bruininks–Oseretsky test scores revealed a significant interaction effect ($F[1, 37] = 31.47$, $p = .000$). Treatment participants improved their mean score from 19.0 to 27.2, whereas control participants remained relatively steady at 20.0 pretest and 21.4 posttest.

Univariate ANOVAs for the standardized scores indicated significant differences between groups in eye–hand coordination scores ($F[1, 50] = 6.24$, $p < .05$), copying scores ($F[1, 50] = 11.37$, $p < .001$), spatial relationships scores ($F[1, 50] = 13.97$, $p < .001$), and total DTVP–2 standard scores ($F[1, 50] = 13.62$, $p = .001$). The treatment group improved its scores on these measures by at least 60%, whereas the control group improved its scores by no more than 47%. The standard DTVP–2 score was higher by a mean of 7.5 points among the treatment group and by a mean of 2.7 points among the control group (Table 2).

Analysis of Demographic Effects

Three-way repeated MANOVA measures revealed a significant interaction of Group × Religion × Time in eye–hand coordination raw scores ($F[1, 48] = 4.01$, $p = .05$). Additional two-way (Group × Religion) ANOVAs for different scores indicated higher improvement among Jewish treatment participants (M = 70.3% improvement, SD = 30.8) than Arab participants (M = 55.1% improvement, SD = 17.9). The scores of control participants from both religious groups did not differ significantly (Jewish participants, M = 35.4, SD = 29.6; Arab participants, M = 45.3, SD = 33.7). The ANOVA comparison for Group × Religion was not statistically significant. Three-way repeated MANOVA measures revealed a nonsignificant interaction of Group × Gender × Time in DTVP–2 scores (multivariate $F[4, 45] = 2.28$, p = ns).

Table 1. DTVP–2 and Bruininks–Oseretsky Raw Scores of Study and Control Groups Before and After Intervention

	Before Intervention Study Group		After Intervention Control Group		Study Group		Control Group	
Score	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)	*M*	(*SD*)
DTVP–2								
Eye–hand coordination	134.96	(22.56)	143.57	(15.21)	152.79	(15.79)	149.32	(11.59)
Copying	16.00	(4.62)	16.64	(3.41)	19.63	(4.62)	17.71	(3.67)
Visual–motor speed	9.46	(4.04)	10.39	(4.40)	14.83	(5.47)	14.75	(6.70)
Spatial relations	23.08	(9.62)	24.25	(8.85)	35.79	(6.49)	29.14	(8.46)
Total DTVP–2	36.21	(4.99)	36.79	(5.30)	43.75	(5.43)	39.50	(6.29)
Bruininks–Oseretsky test	19.00	(3.12)	20.04	(4.43)	27.20	(3.30)	21.38	(5.07)

Note. DTVP–2 = Developmental Test of Visual Perception (Hammill, Pearson, & Voress, 1993); Bruininks–Oseretsky = Bruininks–Oseretsky Motor Development Scale (Bruininks, 1978).

Table 2. Percentage of Difference in DTVP–2 and Bruininks–Oseretsky Scores of Study and Control Groups Before and After Intervention

	Study Group		Control Group	
Score	*M*	(*SD*)	*M*	(*SD*)
Eye–hand coordination	61.46	(24.69)	41.42	(31.96)
Copying	60.82	(28.14)	36.50	(23.89)
Visual–motor speed	56.29	(26.46)	47.36	(26.46)
Spatial relations	69.18	(23.22)	42.78	(27.08)
Total DTVP–2 standard score	7.54	(4.30)	2.71	(5.02)

Note. DTVP–2 = Developmental Test of Visual Perception (Hammill, Pearson, & Voress, 1993); Bruininks–Oseretsky = Bruininks–Oseretsky Motor Development Scale (Bruininks, 1978). Subscale difference score are expressed as percentage of the differences between pretest vs. posttest raw scores. Total DTVP–2 score is expressed as the difference between standard scores.

Discussion

This study tested the efficacy of a short-term intervention to improve visual–motor skills in first graders from low socioeconomic backgrounds. The significant interaction we found between group (treatment and control) and intervention (pretest–posttest scores) in almost all dependent variables adds to evidence-based research by supporting the efficacy of occupational therapy intervention in improving the visual–motor skills of preschool and first-grade children (Dankert et al., 2003; Oliver, 1990; Parush & Hahn-Markowitz, 1997). The study's focus on a short-term intervention differs from that of most previous studies, which sought to prove the efficacy of interventions lasting 7 or more months (Addy, 1997; Case-Smith, 1996, 2002; Parush & Hahn-Markowitz, 1997).

In this study, we found significant differences in the treatment group's total standard scores on the DTVP–2 before and after intervention. The treatment group also improved significantly in comparison to the control group. The literature review supported our results: Intervention improves impaired visual–motor skills, and the developmental disadvantages of untreated children with disabilities remain constant (Marr & Cermak, 2001).

Focused intervention on spatial relationships, including copying figures from among dots, may explain the significant improvement of treated children compared with the control group as reflected in the eye–hand coordination subtest scores on the DTVP–2. Conversely, no significant differences were found between the treatment and control groups on the test of visual–motor speed; success in this subtest requires children to understand and remember the coding key while performing the task, in addition to achieving accuracy and speed, but the intervention did not include specific practice on coding or memory skills. To improve test scores, it is important to give children focused practice on the desired skills (Polatajko et al., 1995). Case-Smith (2002) found that children with writing difficulties ages 7 to 10 years who received occupational therapy intervention significantly improved their writing quality but not their writing speed. Her explanation was that the intervention program did not incorporate speed-oriented activities.

Our results support the prediction that we would find differences between the treatment group and the control group on the fine-motor subtest of the Bruininks–Oseretsky test. The extent of improvement in the treatment group was significantly higher than in the control group. These results are in accord with the results of Case-Smith et al. (1998), who found that structured occupational therapy intervention to improve hand manipulation among kindergartners brought about improvement in fine-motor abilities. They concluded that intervention helps children with disabilities close their developmental gap and even accelerate normal development over a given time.

Cultural Diversity

The Israeli population is culturally diverse, and researchers have described differences in behavior and skills among the different cultural groups (Katz, Kizony, & Parush, 2002; Parush, Sharoni, Hahn-Markowitz, & Katz, 2000; Rosenblum, Katz, Hahn-Markowitz, Mazor-Karsenty, & Parush, 2000). Josman, Abdallah, and Engel-Yeger (2006) studied children in kindergarten, first grade, and second grade and found significant differences between Jewish and Arab children in visual–motor and visual–perceptual test results. In our study, no significant differences were found between Arab and Jewish children on all measures except for the eye–hand coordination subtest; these results contrasted with our expectation that there would be differences between Arab and Jewish children in motor development (Arama, Pinsky, Koren, & Rosenblum, 2002; Rosenblum, Katz, & Parush, 1997).

Although the occupational therapy students who conducted the intervention were Hebrew speakers who spoke little Arabic and the children in the treatment group spoke little Hebrew, we believe that our results were not affected by the language differences; being aware of the language barrier, we included only activities that could be explained by visual demonstrations in the intervention kits.

Limitations and Recommendations

The control group did not receive any intervention while participating in the study; future researchers may wish to study the efficacy of the visual–motor intervention with additional control groups treated using different intervention methods. An important future research contribution would be to assess the effect of improved visual–motor skills following a short-term treatment program on children's participation in other school activities and on their writing skills.

The movement toward evidence-based practice in health care calls on occupational therapists to find and use evidence as a basis for their interventions. Israeli school-based clinicians and researchers have used the treatment plan proposed in this research for the past few years. This study has provided preliminary evidence that this short-term graphomotor intervention is effective, adding to the evidence-based knowledge of occupational therapists. ▲

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References

Addy, M. L. (1997). A perceptual–motor approach to handwriting. *British Journal of Occupational Therapy, 59,* 427–432.

Alexander, K. L., Entwisle, D. R., & Olson, L. S. (2001). Schools, achievement, and inequality: A seasonal perspective. *Educational Evaluation and Policy Analysis, 23,* 171–191.

Arama, K., Pinsky, M., Koren, G., & Rosenblum, S. (2002). The hand skills and dexterity in 5–6 year old children of Israeli Ethiopian immigrant parents versus children of Israeli-born parents. *Israeli Journal of Occupational Therapy, 1,* 1–9.

Beery, K. E. (1997). *The Beery–Buktenica Developmental Test of Visual–Motor Integration (VMI): Administration, scoring, and teaching manual* (4th ed.). Cleveland, OH: Modern Curriculum Press.

Benbow, M. (1995). Principles and practices of teaching handwriting. In A. Henderson & C. Pehoski (Eds.), *Hand function in the child* (pp. 255–281). St. Louis, MO: Mosby-Yearbook.

Bruininks, R. H. (1978). *Bruininks–Oseretsky Test of Motor Proficiency: Examiner's manual.* Circle Pines, MN: American Guidance Service.

Case-Smith, J. (1996). Fine motor outcomes in preschool children who receive occupational therapy. *American Journal of Occupational Therapy, 50,* 52–61.

Case-Smith, J. (2002). Effectiveness of school-based therapy intervention on handwriting. *American Journal of Occupational Therapy, 56,* 17–25.

Case-Smith, J., Heaphy, T., Marr, D., Galvin, B., Koch, V., Good-Ellis, M., et al. (1998). Fine motor and functional performance outcomes in preschool children. *American Journal of Occupational Therapy, 52,* 788–796.

Cornhill, H., & Case-Smith, J. (1996). Factors that relate to good and poor handwriting. *American Journal of Occupational Therapy, 50,* 732–739.

Daly, C. J., Kelley, G. T., & Krauss, A. (2003). Relationship between visual–motor integration and handwriting skills of children in kindergarten: A modified replication study. *American Journal of Occupational Therapy, 57,* 459–462.

Dankert, H. L., Davis, P. L., & Gavin, W. J. (2003). Occupational therapy effects on visual–motor skills in preschool children. *American Journal of Occupational Therapy, 57,* 542–549.

Efraim, D. (2002). *Efficacy of short term treatment intervention on grapho-motor components required for the writing process in first grade students.* Unpublished master's thesis. Tel Aviv University, Israel.

Hammill, D., Pearson, N. A., & Voress, J. K. (1993). *Developmental Test of Visual Perception* (2nd ed.). Austin, TX: Pro-Ed.

Hamstra-Bletz, L., & Blote, A. W. (1993). A longitudinal study on dysgraphic handwriting in primary school. *Journal of Learning Disabilities, 26,* 689–699.

Humphry, R., Jewell, K., & Rosenberg, R. C. (1995). Development of in hand manipulation and relationship with activities. *American Journal of Occupational Therapy, 49,* 763–771.

Josman, N., Abdallah, T. M., & Engel-Yeger, B. (2006). A comparison of visual–perceptual and visual–motor skills between Palestinian and Israeli children. *American Journal of Occupational Therapy, 60,* 215–225.

Katz, N., Kizony, R., & Parush, S. (2002). Visuomotor organization and thinking operations performance of school-age Ethiopian, Bedouin, and mainstream Israeli children. *Occupational Therapy Journal of Research, 22,* 34–43.

Lazlo, J. I., & Bairstow, P. J. (1984). Handwriting difficulties and possible solutions. *School Psychology International, 5,* 207–213.

Laszlo, J. I., & Broderick, P. (1991). Drawing and handwriting difficulties: Reasons and remediation of dysfunction. In J. Wann, A. M. Wing, & N. Sovik (Eds.), *Development of graphic skills: Research, perspectives, and educational implications* (pp. 259–285). London: Academic Press.

Levine, M. D. (1987). *Developmental variation and learning disorders.* Cambridge, MA: Educators Publishing Service.

Levine, M. D., Oberklaid, F., & Meltzer, L. (1981). Developmental output failure: A study of low productivity in school aged children. *Pediatrics, 67,* 18–25.

Lifshitz, N., & Parush, S. (1999). *Brief Assessment Tool for Handwriting (BATH)* (3rd ed.). Jerusalem: Hebrew University, School of Occupational Therapy.

Linder, K. J. (1986). Transfer to motor learning: From formal discipline to action systems theory. In L. D. Zaichkowsky & C. Z. Fuches (Eds.), *The psychology of motor behavior: Development, control, learning and performance* (pp. 65–87). Ithaca, NY: Mouvement Publications.

Lockhart, J., & Law, M. (1994). The effectiveness of a multisensory writing programme for improving cursive writing ability in children with sensori-motor difficulties. *Canadian Journal of Occupational Therapy, 61,* 206–214.

Margalit, M. (1998). Loneliness and coherence among preschool children with learning disabilities. *Journal of Learning Disabilities, 31,* 173–180.

Marr, D., & Cermak, C. (2001). Consistency of handwriting development in the early elementary years: A literature review. *Israeli Journal of Occupational Therapy, 10,* 109–130.

McHale, K., & Cermak, S. (1992). Fine motor activities in elementary school: Preliminary findings and provisional implications for children with fine motor problems. *American Journal of Occupational Therapy, 46,* 898–903.

Oliver, C. E. (1990). A sensorimotor program for improving writing readiness skills in elementary age children. *American Journal of Occupational Therapy, 44,* 111–116.

Parush, S., & Hahn-Markowitz, J. (1997). A comparison of two settings for group treatment in promoting perceptual–motor function of learning disabled children. *Physical and Occupational Therapy in Pediatrics, 17,* 45–56.

Parush, S., Sharoni, C., Hahn-Markowitz, J., & Katz, N. (2000). Perceptual, motor, and cognitive performance components of Bedouin children in Israel. *Occupational Therapy International, 7,* 216–231.

Pavri, S., & Monda-Amaya, L. (2000). Loneliness and students with learning disabilities in inclusive classrooms: Self-perceptions, coping strategies, and preferred interventions. *Learning Disabilities Research and Practice, 15,* 22–33.

Polatajko, H. J., MacNab, J. J., Ansett, B., Malloy-Miller, T., Murphy, K., & Noh, S. (1995). A clinical trial of the process-oriented treatment approach for children with developmental coordination disorders. *Developmental Medicine and Child Neurology, 37,* 310–319.

Rappolt, S. (2003). The role of professional expertise in evidence-based occupational therapy. *American Journal of Occupational Therapy, 57,* 589–593.

Reisman, J. (1991). Poor handwriting: Who is referred? *American Journal of Occupational Therapy, 45,* 849–852.

Rosenblum, S., Katz, N., & Parush, S. (1997). Visual–motoric functioning of new-immigrant children from Ethiopia, as compared to children of veteran Ethiopian immigrants and to Israeli children. *Israeli Journal of Occupational Therapy, 6,* 1–19.

Rosenblum, S., Katz, N., Hahn-Markowitz, J., Mazor-Karsenty, T., & Parush, S. (2000). Environmental influences on perceptual and motor skills of children from immigrant Ethiopian families. *Perceptual and Motor Skills, 90,* 587–594.

Schneck, C. M. (1991). Comparison of pencil-grip patterns in first graders with good and poor writing skills. *American Journal of Occupational Therapy, 45,* 701–706.

Schoemaker, M. M., & Kalverboer, A. F. (1994). Social and affective problems of children who are clumsy: How early do they begin? *Adaptive Physical Activity Quarterly, 11,* 130–140.

Taylor, K. M. (1999). Relationship between visual motor integration skill and academic performance in kindergarten through third grade. *Optometry and Vision Science, 76,* 159–163.

Tseng, M. H., & Chow, S. M. K. (2000). Perceptual–motor function of school-age children with slow handwriting speed. *American Journal of Occupational Therapy, 54,* 83–88.

Valmaggia, L. R., Van der Gaag, M., Tarrier, N., Pijnenborg, M., & Slooff, C. F. (2005). Cognitive–behavioural therapy for refractory psychotic symptoms of schizophrenia resistant to atypical antipsychotic medication: Randomised controlled trial. *British Journal of Psychiatry, 186,* 324–330.

Weil, M. J., & Cunningham Amundson, S. J. (1994). Relationship between visuomotor and handwriting skills of children in kindergarten. *American Journal of Occupational Therapy, 48,* 982–988.

Wilson, B. N., Polatajko, H. J., Kaplan, B. J., & Faris, P. (1994). Use of the Bruininks–Oseretsky Test of Motor Proficiency in occupational therapy. *American Journal of Occupational Therapy, 29,* 8–17.