
Effectiveness of a 10-Week Tier-1 Response to Intervention Program in Improving Fine Motor and Visual–Motor Skills in General Education Kindergarten Students

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MeSH TERMS

- cooperative behavior
- motor skills
- psychomotor performance
- school health services
- treatment outcome

OBJECTIVE. This study examined the efficacy of a 10-wk Tier 1 Response to Intervention (RtI) program developed in collaboration with classroom teachers to improve the fine motor and visual–motor skills of general education kindergarten students.

METHOD. We recruited 113 students in six elementary schools. Two general education kindergarten classrooms at each school participated in the study. Classrooms were randomly assigned to the intervention and control groups. Fine motor skills, pencil grip, and visual–motor integration were measured at the beginning of the school year and after the 10-wk intervention.

RESULTS. The intervention group demonstrated a statistically significant increase in fine motor and visual–motor skills, whereas the control group demonstrated a slight decline in both areas. Neither group demonstrated a change in pencil grip.

CONCLUSION. This study provides preliminary evidence that a Tier 1 RtI program can improve fine motor and visual–motor skills in kindergarten students.

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The Response to Intervention (RtI) provision in the 2004 reauthorization of the Individuals With Disabilities Education Improvement Act (IDEA 2004; Pub. L. 108–446) provides additional opportunities for occupational therapy practitioners to contribute to the success of general education students (American Occupational Therapy Association [AOTA], 2011). Under IDEA 2004, the exact role of occupational therapy practitioners varies from state to state. Their general role, however, is to work with other school professionals to develop prevention programs designed to minimize learning and behavioral problems at the individual, classroom, and schoolwide levels (AOTA, 2011). Although RtI has received increasing attention in the occupational therapy literature and professional documents over the past 4 years (e.g., AOTA, 2008, 2010a, 2010b, 2011; Clark, Brouwer, Schmidt, & Alexander, 2008), little evidence is available of the effectiveness of RtI programs involving collaborations between occupational therapy practitioners and other school professionals. We conducted a study to examine the effectiveness of a Tier 1 RtI program designed to improve the fine motor and visual–motor integration skills of general education kindergarten students early in the school year.

RtI Model

RtI is a proactive, multitiered method of service delivery in which all students are provided an appropriate level of evidence-based instruction according to their academic and behavioral needs (Barnes & Harlacher, 2008). Under the RtI model, practitioners use frequent assessments and progress monitoring to identify at-risk students and provide these students with the immediate intervention they need to make continued academic progress. Intervention may involve the implementation of alternative instructional methodologies; small-group skills remediation; or more intensive instruction, such as individual tutoring sessions (AOTA, 2008). After an intervention is implemented, practitioners reassess students to determine whether they are receiving the right behavioral or instructional supports.

RtI typically follows a three-tiered intervention approach, with each tier serving a decreasing number of students with an increasing intensity of service and monitoring. *Tier 1* RtI involves universal interventions, including schoolwide or whole-classroom practices. Tier 1 takes place in the general education classroom and reaches the greatest number of students while providing the least intensive intervention. The primary goals of Tier 1 RtI are, by providing a high-quality, research-based curriculum, to improve overall student success and to prevent the need for additional, more restrictive services for at-risk students. The second and third tiers of RtI involve small-group and individual instruction for students for whom less intensive instruction is insufficient. Although occupational therapy professionals can contribute to any tier of RtI, our study used a Tier 1 RtI intervention approach to reach the largest number of students and facilitate collaboration and knowledge exchange between classroom teachers and occupational therapists.

Fine Motor and Visual–Motor Demands of Kindergarten

Effective fine motor skills are essential for kindergarten success. Research has suggested that kindergarten students spend a significant portion of the school day (36%–66%) performing a variety of fine motor activities, such as eating breakfast, playing with Legos[®], coloring, and writing (Marr, Cermak, Cohn, & Henderson, 2003). Children who struggle with the fine motor demands of kindergarten are at risk of falling behind, becoming dependent on others, being teased by their peers, and developing low perceived scholastic competence (Losse et al., 1991; Piek, Baynam, & Barrett, 2006). The implications of poor fine motor skills

extend beyond kindergarten: Several studies have found fine motor performance in kindergarten to be a strong predictor of later math and reading achievement (Cameron et al., 2012; Grissmer, Grimm, Aiyer, Murrah, & Steele, 2010).

Fine motor and handwriting concerns are the two most common reasons for referral to a school-based occupational therapist (Schneck & Amundson, 2010). Handwriting is a complex fine motor act requiring a combination of cognitive and perceptual–motor skills (Cornhill & Case-Smith, 1996; Volman, van Schendel, & Jongmans, 2006). In kindergarten, the majority of children are ready to begin handwriting instruction during the second half of the school year (Daly, Kelley, & Krauss, 2003; Marr, Windsor, & Cermak, 2001). During the first half of the school year, kindergarten students may benefit from improving the underlying performance skills of handwriting.

Research largely indicates that visual–motor integration not only is the strongest predictor of handwriting legibility (Daly et al., 2003; Volman et al., 2006) but also is significantly related to academic performance in young children (Kulp, 1999). Additionally, two fine motor skills—in-hand manipulation and sequential finger opposition—strongly correlate with handwriting performance (Berninger & Rutberg, 1992; Cornhill & Case-Smith, 1996). Because fine motor and visual–motor integration skills are essential to kindergarten performance as well as predictive of later achievement, they require prompt intervention when a concern arises.

Fine Motor and Visual–Motor Intervention Research

Several studies have indicated that occupational therapy–led fine motor and visual–motor intervention programs are effective in preschool and lower elementary school (Bazyk et al., 2009; Case-Smith, 1996, 2002; Dankert, Davies, & Gavin, 2003; Ratzon, Efraim, & Bart, 2007). Most of these studies found improvements among children with disabilities or delays who received direct occupational therapy services throughout the course of the school year. Studies by Ratzon et al. (2007), Bazyk et al. (2009), and Rule and Stewart (2002) were foundational to the current study.

Ratzon et al. (2007) examined the effectiveness of a 12-wk intervention targeting handwriting and fine motor performance skills in first-grade children with fine motor delays. They found that the intervention group made significantly greater improvements in eye–hand coordination, copying, and fine motor skills than the control group. These findings are particularly meaningful

to our study in that they provide preliminary evidence for the effectiveness of short-term fine motor interventions.

Bazyk et al. (2009) measured visual-motor and fine motor outcomes in kindergarten children with and without disabilities who received occupational therapy services embedded in the curriculum for the entire school year. They found that children without disabilities made statistically significant changes in all eight visual-motor and fine motor measures, whereas children with disabilities made significant changes in two of the fine motor assessments. Their findings lend support for examining the effects of a visual-motor and fine motor intervention on general education students without disabilities.

Rule and Stewart (2002) examined the effectiveness of six teacher-introduced fine motor centers in increasing the pincer grasp of general education kindergarten students attending a Montessori school. They found that although the kindergarten classrooms were rich with fine motor activities, carefully constructed and coached activities were more effective in improving pincer grasp than mere exposure to daily fine motor activities. These findings lend support for this study's use of a teacher- and therapist-introduced fine motor center in the classroom.

Research Question

The primary research question for this study was, Will general education kindergarten students who receive a 10-wk RtI program demonstrate significantly greater improvements in fine motor and visual-motor skills than general education kindergarten students who do not receive a 10-wk RtI program?

Method

Research Design

We used a pretest-posttest control-group design (Creswell, 2003) to measure fine motor and visual-motor outcomes in kindergarten students in general education classrooms at six urban elementary schools. In each school, two general education kindergarten classrooms were recruited to participate in the study. One of the classrooms was assigned to the intervention group, and the other classroom was assigned to the control group. We assessed participants in both the intervention and control groups before and after a 10-wk period. For ethical reasons, the control group then received the intervention after the study period was complete. The institutional review board of the New York City Department of Education approved the study protocol.

Participant Selection

Twelve general education kindergarten classrooms participated in the study. All kindergarten students in both the intervention and control classrooms were invited to participate in this study. Written caregiver permission and signed child assent were obtained for all study participants. Consent was also obtained from school principals, occupational therapists, and teachers.

Measures

Fine motor skills were assessed using the Bruininks-Oseretsky Test of Motor Proficiency, 2nd Edition (BOT-2; Bruininks & Bruininks, 2005). The BOT-2 is a standardized test of gross and fine motor skills in children aged 4–21 yr. We administered the BOT-2 Manual Coordination subscale, which contains the manual dexterity and upper-limb coordination subtests, to all participants at baseline and after the intervention period was complete. The Manual Coordination subscale has acceptable test-retest reliability ($r = .62-.79$) and interrater reliability ($r = .98$; Bruininks & Bruininks, 2005).

Visual-motor skills were assessed with the Beery-Buktenica Developmental Test of Visual-Motor Integration, 5th edition (VMI; Beery, Beery, & Buktenica, 2004). The VMI is a norm-referenced standardized test for children aged 2–18 yr that requires the child to draw geometric forms arranged in a developmental sequence. The VMI has sound psychometric properties, with high interrater ($r = .92$) and test-retest reliability ($r = .89$; Beery et al., 2004). A short form containing only 21 items is available for children aged 2–7 yr; the short form was used in this study and administered in a group.

Pencil grip was assessed with the Developmental Scale of Pencil and Crayon Grips (Schneck & Henderson, 1990), which describes and provides pictures of 10 types of pencil or crayon grips used by children. The scale was developed by analyzing the grips of 320 typically developing children ranging in age from 3 yr to 6 yr, 11 mo while they performed both drawing and coloring tasks. Although a large number of children at all ages used mature pencil grips, the scale developers found and documented a developmental progression.

We developed the Therapist-Teacher Interaction Log for this study to provide a framework for occupational therapists to keep track of the time spent in the classroom each week and the type of contact they had with the intervention teacher. We also developed a survey to assess the classroom teachers' use of strategies or modifications learned directly from the occupational therapists, the number of students referred for occupational therapy, the

continued use of the fine motor center, and continued consultation with the occupational therapist 3 mo postintervention.

Intervention

The Specialized Teaching and Enhancement of Performance Skills for Kindergarteners (STEPS–K) program was developed for this study by Hollie Graze and Karen Weber in collaboration with general education kindergarten teachers to promote the fine motor and visual–motor skills necessary for success in the kindergarten curriculum. The STEPS–K program consisted of three main parts: (1) direct intervention, in which an occupational therapist led ten 30-min lessons in collaboration with the classroom teacher once a week for 10 consecutive weeks; (2) a classroom fine motor center with new activities introduced throughout the 10 lessons; and (3) additional consultation time between the occupational therapist and teacher throughout the 10-wk intervention period. Core elements of the STEPS–K program were as follows:

- Occupational therapists and teachers implemented each lesson following a script from the STEPS–K program manual.
- Teachers were provided with visual aids to go along with each lesson (e.g., lesson plans, classroom posters, parent handouts).
- Therapists and teachers modeled skills at the start of each lesson and provided opportunities for students to practice. Therapists and teachers monitored and assisted students as needed. At the conclusion of each lesson, students were asked to identify the key points of each new skill.
- A fine motor center containing activities with picture cards and instructions was integrated into the daily classroom routine.
- Therapists consulted with teachers to recommend specific strategies for assisting struggling students, incorporating the fine motor centers into their classrooms, and reinforcing skills throughout the school day.

Occupational therapists provided lesson plans to the teachers in advance. The teachers supplied materials and set up the classroom as needed. The first lesson focused on positioning, posture, and breath. In subsequent lessons, occupational therapists introduced the eight activities included in the fine motor center. Skills addressed in the fine motor center included strengthening of the intrinsic hand musculature, finger isolation and pincer grasp exercises, separation of the two sides of the hand, translation, rotation, opposition, visual–perceptual and visual–

motor skills, and bilateral coordination. As each activity was presented, the classroom teacher added it to the fine motor center and incorporated it during the school day. Other lessons included in the STEPS–K program were how to hold a pencil, cut with scissors, draw a person, and put on a coat.

Data Collection

Data were collected at the beginning of the school year (pretest) and again midyear (posttest) using the same assessment battery. All data were collected by the same occupational therapists (Kenny, Salvatore, and Wagreich), who were trained in administering the assessments and provided the weekly classroom interventions. These occupational therapists recorded raw scores during the BOT–2 administration, identified the participants' pencil grip on the Developmental Scale of Pencil and Crayon Grips, and administered the VMI, but they did not score the assessments.

Scoring and Data Analysis

Five experienced occupational therapists who were not involved in the intervention and who were blind to the study conditions converted BOT–2 raw scores into standard scores and scored the short form of the VMI. They numbered each of the 10 pencil grips on the Developmental Scale of Pencil and Crayon Grips in order of use. All demographic and outcomes data were entered into SPSS Version 20 (IBM Corporation, Armonk, NY).

Results

Participants

We originally collected data on 113 students across six elementary schools. Two schools were not able to collect posttest data within the allotted timeline of the study; thus, we did not include their data in the analysis. We analyzed data from 75 students (33 girls, 42 boys; mean age = 5.19 yr, standard deviation = 0.34) at four elementary schools. The demographic characteristics of the intervention and control groups were well matched across all variables, including age, $t(73) = 0.301, p = .764$; gender, $\chi^2(1, N = 75) = 0.107, p = .744$; ethnicity, $\chi^2(4, N = 66) = 4.391, p = .356$; and receipt of related services, $\chi^2(2, N = 70) = 3.68, p = .159$. Table 1 provides additional demographic characteristics.

Four occupational therapists (Kenny, Salvatore, and Wagreich and another therapist who was not a co-author), 1 at each of the four participating elementary schools, administered the STEPS–K program and assessed students.

Table 1. Demographic Characteristics (N = 75)

Characteristic	Intervention Group (n = 47)	Control Group (n = 28)
Gender, n (%)		
Male	27 (57.4)	15 (53.6)
Female	20 (42.6)	13 (46.4)
Race or ethnicity, n (%)		
White	11 (23.4)	12 (42.9)
Black or African American	2 (4.3)	1 (3.6)
Asian	12 (25.5)	7 (25.0)
Hispanic or Latin American	11 (23.4)	6 (21.4)
Two or more	4 (8.5)	0 (0)
Not reported	7 (14.9)	2 (7.1)
Related services received, n (%)		
Occupational therapy	4 (8.5)	3 (10.7)
Physical therapy	1 (2.1)	1 (3.6)
Speech therapy	1 (2.1)	1 (3.6)
Counseling	3 (6.4)	2 (7.1)
Special education teacher support	3 (6.4)	2 (7.1)
Other	3 (6.4)	2 (7.1)
Age, yr, M (SD)	5.18 (0.35)	5.20 (0.34)

Note. M = mean; SD = standard deviation.

Eight teachers (4 intervention classroom teachers and 4 control group teachers) also participated in this study. The demographic characteristics of the occupational therapists and the classroom teachers are provided in Table 2.

Fine Motor and Visual–Motor Performance

The means and standard deviations of the VMI and BOT–2 pretest and posttest scores, along with paired *t*-test results and effect sizes, are provided in Table 3. At the onset of the study, no statistically significant differences were found between the intervention and control groups in scores on the VMI, $t(72) = -0.419$, $p = .677$, and BOT–2, $t(73) = 0.206$, $p = .837$. Six students missed the VMI posttest, and 1 missed the BOT–2 posttest. We used paired-samples *t* tests to test the hypothesis that the intervention group would demonstrate significantly greater improvements on the VMI and BOT–2 than the control group. Results indicate that the intervention group had a significant

improvement in VMI and BOT–2 average scores and that the control group demonstrated a slight decrease in VMI and BOT–2 average scores.

Pencil Grip

Pencil grip was assessed pre- and postintervention with the Developmental Scale of Pencil and Crayon Grips while children participated in classroom writing assignments. The frequencies of each pencil grip are provided in Table 4. No significant differences in pencil grip existed between the intervention and control groups either at the onset of the study, $\chi^2(7, N = 73) = 11.31$, $p = .126$, or after the intervention, $\chi^2(5, N = 70) = 2.41$, $p = .790$.

Therapist–Teacher Interaction Logs

According to the Therapist–Teacher Interaction Logs, the 4 staff occupational therapists spent a total of 573 min with the intervention classroom teacher throughout the duration of the intervention period in addition to the 10 weekly lessons. On average, occupational therapists spent between 6 and 33 min/wk consulting with the intervention teachers. The most common topic of consultation was integration of occupational therapy into the curriculum.

Teacher Follow-Up Survey

At 3 mo postintervention, the intervention classroom teachers completed a follow-up survey. According to the results, 75% of the teachers were still using the fine motor center with their class. One teacher who was no longer using the fine motor center reported that academic demands did not allow for its continued use. All 4 teachers reported using strategies learned from the occupational therapists. The most commonly cited strategies were for teaching students how to correctly hold a pencil and scissors. Since the end of the intervention, 3 teachers had referred 1 child to occupational therapy, and 1 teacher had referred 2 children. Additionally, 3 teachers reported continuing to consult with the occupational therapist at their school.

Table 2. Demographic Characteristics of the Occupational Therapists and Classroom Teachers (N = 12)

Characteristic	Occupational Therapists (n = 4)	Intervention Group Classroom Teachers (n = 4)	Control Group Classroom Teachers (n = 4)
Years licensed, M (SD)	12.50 (11.85)	13.00 (7.26)	14.25 (9.50)
Years of pediatric experience, M (SD)	8.00 (6.73)	10.75 (6.85)	13.25 (10.40)
Highest degree, n (%)			
Bachelor's	1 (25)	0	0
Master's	3 (75)	4 (100)	4 (100)

Note. M = mean; SD = standard deviation.

Table 3. Fine Motor and Visual–Motor Pretest and Posttest Scores ($N = 75$)

Assessment	Intervention Group ($n = 47$)				Control Group ($n = 28$)		
	Pretest, M (SD)	Posttest, M (SD)	t (p)	Effect Size (Cohen's d)	Pretest, M (SD)	Posttest, M (SD)	t (p)
VMI (visual–motor)	103.67 (11.54)	107.00 (12.16)	-2.46 (.009**)	-0.34	102.61 (8.89)	101.93 (10.82)	0.336 (.370)
BOT–2 (fine motor)	46.51 (9.84)	48.39 (10.32)	-2.06 (.023*)	-0.24	46.96 (8.02)	45.57 (8.86)	1.203 (.120)

Note. BOT–2 = Bruininks–Oseretsky Test of Motor Proficiency, 2nd Edition; M = mean; SD = standard deviation; VMI = Beery–Buktenica Developmental Test of Visual–Motor Integration, 5th edition.

* $p < .05$. ** $p < .01$ (one-tailed).

Discussion

This study tested the efficacy of a short-term Tier 1 RtI program developed to improve the fine motor and visual–motor integration skills of general education kindergarten students at the beginning of the school year. VMI and BOT–2 scores indicated that the intervention group made statistically significant improvements over the 10-wk study period, whereas the control group demonstrated a slight decline in scores. These results support the findings of Ratzon et al. (2007), who also found fine motor improvements after an abbreviated intervention period. These results are also consistent with the findings of Bazyk et al. (2009) and Rule and Stewart (2002), who found improvements after implementing programs that combined direct intervention and consultation and teacher-introduced fine motor centers, respectively. In this study, the combination of direct and consultation services with the fine motor center most likely contributed to the program's success.

Although this study found significant fine motor and visual–motor outcomes, the effect sizes for the intervention results were small (VMI Cohen's $d = -0.34$; BOT–2 Cohen's $d = -0.24$), indicating minimal improvements. This result may be attributable to the relatively short timeline of the study or the initial skill level of the participants, which was largely within the average range.

Another possible explanation is that the intervention is only modestly effective. Further study is needed to examine the effectiveness of the STEPS–K program and other short-term Tier 1 RtI programs.

In addition to improved BOT–2 scores, both the intervention and control groups demonstrated changes in pencil grip from the onset of the study to the end of the study (see Table 4); however, these changes were not statistically significant. This finding is interesting given that the intervention group received explicit instruction on how to hold the pencil using a mature tripod grasp and provides evidence that pencil grip is dynamic in young children. Further research is needed to examine the stability of pencil grip over time.

In addition to examining fine motor and visual–motor outcomes, this study also followed the RtI model by fostering collaboration between classroom teachers and occupational therapists. Data from the Therapist–Teacher Interaction Logs and the 3-mo teacher follow-up survey indicate that this collaboration took place. In addition to the 10 weekly sessions, therapists spent time in the classroom consulting with teachers about individual students and the curriculum. Most of the teachers reported not only continued use of the fine motor center and strategies learned during the 10 lessons but also continued consultation with the occupational therapist after the study was complete.

Table 4. Pencil Grip Frequencies

Pencil Grip	Intervention Group, n (%)		Control Group, n (%)	
	Pretest ($n = 46$)	Posttest ($n = 43$)	Pretest ($n = 27$)	Posttest ($n = 27$)
1. Radial cross palmar	0	0	0	0
2. Palmar supinate	1 (2.2)	0	0	0
3. Digital pronate, index finger extended	1 (2.2)	0	0	0
4. Brush grasp	0	0	0	0
5. Grasp with extended fingers	4 (8.7)	1 (2.3)	6 (22.2)	1 (3.7)
6. Cross thumb	4 (8.7)	5 (11.6)	4 (14.8)	5 (18.5)
7. Static tripod	19 (41.3)	8 (18.6)	3 (11.1)	3 (11.1)
8. Four fingers	6 (13.0)	3 (7.0)	7 (25.9)	2 (7.4)
9. Lateral tripod	5 (10.9)	2 (4.7)	2 (7.4)	3 (11.1)
10. Dynamic tripod	6 (13.0)	24 (55.8)	5 (18.6)	13 (48.2)

Limitations and Future Research

The small sample size and use of one geographic location limit the generalizability of this study. This study is also further limited by the use of outcome measures that examine only performance skills and not functional performance. An important future research contribution would be to assess the number and types of occupational therapy evaluation referrals generated by RtI intervention and control classrooms. Another meaningful analysis would use mixed methods or qualitative methodology to examine occupational therapists' perspectives on the collaboration process with classroom teachers. Last, research is needed to examine whether children who receive a Tier 1 RtI program perform better during midyear handwriting tasks than a control group.

Implications for Occupational Therapy Practice

We found a Tier 1 RtI approach to be effective in improving the fine motor and visual–motor skills of kindergarten children at the beginning of the school year. Our findings have the following implications for occupational therapy practitioners:

- Occupational therapy practitioners have a beneficial role in contributing effective Tier 1 strategies and practices that support the needs of students in the classroom environment.
- Short-term interventions can have a significant effect on the fine motor and visual–motor integration skills required for handwriting readiness.
- Collaboration provides teachers with skills and tools they can use in the future with or without the occupational therapy practitioner present. ▲

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