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The Effect of Fine Motor Skill Activities on Kindergarten Student Attention

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This study explored the effect of fine motor skill activities on the development of attention in kindergarteners ($n = 68$) in five classes at a suburban public school in the Intermountain West through a pretest/posttest experimental group ($n = 36$) control group ($n = 32$) design. All children received the regular curriculum which included typical fine motor activities such as painting, coloring, writing, and play activities with small items. The treatment was a series of supplemental fine motor activities in which children used tongs, tweezers, and spoons to move small items. The assessment was the attention subtest of the Cognitive Assessment System (CAS) (Naglieri, J. A., & Das, J. P. (1997a). Cognitive assessment system. Itasca, IL: Riverside). A significant group×sex interaction with females positively responding to the treatment was found, suggesting that fine motor skill activities are effective in increasing female kindergartners' attention. Further studies exploring effective materials for males and factors such as student choice and interest are needed.

KEY WORDS: attention; fine motor skills; research; kindergarten; Montessori; curriculum materials.

INTRODUCTION

Importance of Attention to Learning

Attention is critically important to learning. Wittrock (1986) established that attention to learning tasks was more highly correlated with achievement than time on task. Children with attention deficit hyperactivity disorder (ADHD) have lower academic performance than their non-ADHD peers (Barkley, 2006; DuPaul & Stoner, 2003), but the risks associated with inattentive behavior extend beyond this identified population. For example, Warner-Rogers, Taylor, Taylor, and Sandberg (2000) found in a community-based study of seven year old boys that the "presence of even a few inattentive behaviors in early childhood should be viewed as a developmental risk factor" since such behavior "is associated with lower-than-average cognitive ability, poorly developed reading skills, and low self-confidence in the classroom" (p. 534).

Importantly, the negative effect of poor attention in the early years of schooling predicts later academic performance. Alexander, Entwisle, and Dauber (1993) found that children's inattentive behavior in first grade had lasting negative effects that continued to be manifested in the spring of fourth grade on standardized reading/mathematics test scores and report card grades. Howse, Lange, Farran, and Boyles (2003) studied at-risk and not-at-risk groups of kindergartners and second graders. They found that "differences in the younger children's attentional regulation abilities and motivational behaviors in the classroom made an important contribution to early reading achievement scores" (p. 172), even after controlling for vocabulary knowledge. The authors

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also found that at-risk children were more prone to attentional problems, but they concluded that motivation and attentional regulation "are important correlates of achievement for both at-risk and not-at-risk samples" of kindergarten children (p. 168).

In a large study of 1,821 children from 70 schools in England, Merrell and Tymms (2003) assessed reading and mathematics achievement three times from school entry (age 4–5) to the end of the second year of schooling when the children were 6–7 years old. They also assessed the children's inattentive, hyperactive, and impulsive behaviors at the conclusion of the first year of school. Results revealed that the inattention subscale of the behavior rating instrument correlated substantially higher with end of year 2 reading and mathematics achievement than did the hyperactive/impulsive subscale. The authors concluded that inattentive behavior has negative consequences for academic achievement spanning multiple years.

Components of Attention

Based on the literature reviewed thus far, attention appears to be quite important to young children's academic achievement. Up to this point, attention has been discussed as if it is unitary construct, but this not the case. As a consequence of work in psychology and cognitive science, attention has evolved into a multi-faceted construct with a variety of theories and models delineating its components and their functioning (Penkman, 2004). However, according to Thomson and Kerns (2005), "Regardless of which model is adopted, most models include separable components of attention such as the ability to sustain attention over time (vigilance), the ability to attend to stimuli selectively, the ability to alternate or switch attention between two things, and the ability to divide attention so as to maintain more than one ongoing process. (p. 1)"

In addition to this theoretical work, clinicians and researchers have become increasingly interested in attention training. For example, Sohlberg and Meteer (1987a) developed a theory of attention that parsed it into five components: (a) focused, (b) sustained, (c) selective, (d) alternating, and (e) divided. They then developed training materials (called Attention Process Training or APT) for adults structured around their five components (Sohlberg & Meteer, 1987b; Sohlberg, Johnson, Paule, Ruskin, & Mateer, 1994). Others have adapted the APT materials for children. For example, Thomson, Kerns, Seidenstrang, Sohlberg, and Mateer (2001) adapted the APT materials for children ages 4–10, calling the materials Pay Attention! In another adaptation, Butler and Copeland (2002) developed Cognitive Remediation Program (CRP) by supplementing the APT materials with child-appropriate activities and metacognitive training.

Penkman (2004) reviewed the research exploring attention training in children and found that it was a very small body of literature but concluded the findings were promising. The seven studies she reviewed explored three subgroups of children who had undergone pediatric attention training: (a) children who survived cancer affecting the central nervous system, (b) children who experienced traumatic brain injury, (c) and children with attention deficit disorder. Given the importance of attention to learning, this small amount of research is surprising, and its focus only on children with identified disorders leaves attention training for general school populations largely unaddressed.

According to Penkman (2004), the few interventions for children that have been developed, such as Pay Attention! and CRP, show promise; but these interventions, being time and resource intensive, have thus far only been employed in clinical settings. What is needed is an intervention that can be easily delivered to individual students, groups of students, or entire classrooms of students within regular school settings. Only one study was found describing and testing such an intervention.

Over 35 years ago, McCormick and Schnobrich (1971) tested a perceptual-motor training program they developed that involved both gross and fine motor skill activities. The first studies they conducted testing their program revealed that children who received the program experienced greater gains in reading achievement than control children (McCormick, Schnobrich, Footlik, & Poetker, 1968; McCormick, Schnobrich, & Footlik, 1969). Because their program did not provide specific reading instruction, they hypothesized that the improvement came from increased attention, and they tested their hypothesis by conducting a study with four-year-old Montessori school students. Results showed increased attention in the students who received the program (McCormick & Schnobrich, 1971).

Montessori Theory and Practice Related to Attention

Although there is little empirical evidence supporting the relationship between perceptual-motor development and attention development in

non-clinical settings with young school-age children, Montessori theory and practice provide an avenue for conceptualizing this area of inquiry. When watching young children at play, one cannot help but notice that their movement engages their total energy, and their full attention is focused on the movements that they need to perform the task. If the task is pleasurable, the child will often choose to repeat it over and over again, becoming absorbed in the movements and sustaining attention for long periods. Montessori recognized this over a century ago and folded these insights into what Sobe (2004) calls a pedagogy of attention. Attention became a central tenet of Montessori's theory and methods, with repetitive manipulation of objects involving fine motor skills as a cornerstone for both developing and revealing attention in children (Sobe, 2004).

Montessori believed that the key to obtaining a child's attention was through interest and movement (Lillard, 2005). Thus, children in Montessori schools actively engage with a variety of "hands-on" activities requiring them to concentrate as well as hone their fine motor skills. Perception and action are closely related; therefore interest and concentration are secured through movement (Standing, 1984; Travers, 1985). In short, according to Montessori theory, the hand leads the mind. It follows, then, that each time a child engages in a task and fully focuses attention on the required motions, the ability to concentrate increases (Woods, 2000).

Standing (1984) found during observations of Montessori classrooms that voluntary repetition of movement is important for mental development. Honig (2006) claimed that play extends attention span. But neither of these authors presented research evidence supporting their assertions. Lillard (2005) provided a discussion of the extensive research base underpinning Montessori theory and practices, but she did not cite studies that specifically focused on establishing the causal link between fine motor activity and increased attention in young children in school. So, although Montessori theory predicts such a causal link, there is no empirical evidence for it except the McCormick and Schnobrich (1971) study. We set about in the present study to explore this link.

RESEARCH DESIGN

A pretest/posttest control group design was employed. The following sections provide details concerning participants, treatment materials, procedures, and instrumentation.

Participants

All predominantly white children in five half-day kindergarten classes at a suburban school in the Intermountain West ($n = 68$) participated in the study. Table 1 provides mean ages in months by group and sex.

Four experienced kindergarten teachers participated in the study. Teachers volunteered to be in either experimental or control conditions. Two classes taught by two teachers comprised the experimental group ($n = 36$). The remaining three classes served as the control group ($n = 32$) with one teacher instructing both a morning and afternoon section.

Treatment Materials and Procedures

All classrooms used the same curricula with the exception of the experimental classrooms using the fine motor activity boxes. An example of one box will serve to illustrate the nature of the activities (See Figure 1). The "Tropical Fish" box contained 12 miniature tropical fish statues, a cobalt-blue glass bowl, a board with 12 blue painted spools (at various heights), and a pair of tweezers. Students were

Table 1. Average Age in Months by Group and Sex

Group	Sex	*N*	Mean[a]
Experimental	F	23	73.5 (3.2)
	M	13	69.3 (3.0)
Control	F	11	73.6 (3.4)
	M	21	72.5 (3.4)

[a] Standard deviations in ( )

Fig. 1. The tropical fish set

instructed to carefully remove the bowl containing the tropical fish, set out the ocean board with the spools, and grasp the tweezers comfortably. The student then proceeded to grasp a fish with the tweezers and place it on the far left spool on the back row. Once the entire board was filled with the perched fish, the student transferred the fish back into the bowl in reverse order. Finally, students replaced all of the components in the plastic storage box, secured the lid, and put the box away in its storage location.

Fifty different sets of fine motor activities were provided to the experimental classrooms over the course of the study. Each individual activity was housed in a plastic shoebox, with each having step-by-step instructions printed on paper and recorded on an audio tape. Teachers demonstrated how each activity was to be completed by reading the instructions and modeling the steps in the activity or by having the student listen to the detailed recording. Once a particular box had been formally introduced to students, the students could choose that box again at a later time. Activities were added and removed each week, thereby keeping activities fresh and engaging without overwhelming the children or classroom space with too many choices (Lillard, 2005).

Students in the experimental classes were given the various fine motor activity boxes once a day for approximately 15 minutes during the six month study along with the boxes being available for use during free-choice time. All of these activities employed practical life materials used in many Montessori schools, and they all followed Lubienski-Wentworth's (1999) guidelines for effective Montessori materials, being simple, dynamic, self-corrective, and attractive to children.

All of the boxes provided practice in handling delicate items confirming the teacher's trust in the child's sense of responsibility (Rule & Stewart, 2002). Other manipulated objects for the different themes and activities included flat glass marbles, small novelty erasers, pebbles, plastic beads, and shells. Implements used included tongs, tweezers, and spoons. These were particularly effective for practicing fine motor skills because changes in the pincer-hold of the hand magnify the movement at the end of the implement, requiring finer motor control. Research conducted by Rule and Stewart (2002) involving 186 children from 13 classrooms in 4 schools revealed that kindergartners who used the activity boxes over a six-month period had greater increases in fine motor skills compared to a control group.

In the current study, control classrooms did not receive additional or supplemental materials. Students in control classrooms continued with the regular kindergarten curriculum which included fine motor activities such as coloring, writing, creative play with blocks, puzzles, etc. Control group students received self-choice time but did not use the experimental materials.

Instrumentation

At this year round school, students were pretested in December or January and posttested in May or June, depending on track schedules. All children were assessed using subtests of the Standard Battery of the Cognitive Assessment System (CAS) (Naglieri & Das, 1999a), a standardized test that measures the cognitive/neuropsychological functioning of children and adolescents and reports a standard score that has been shown to be both reliable and valid (Naglieri & Das, 1997b). The test is structured around the four components of PASS Theory: planning, attention, simultaneous, and successive. The entire CAS battery was not given to the participants because the study's focus was only on attention. Therefore only the three timed subtests of attention were administered by the authors or trained assistants: (a) Expressive Attention, (b) Visual Selective Attention, and (c) Receptive Attention. The Expressive Attention subtest consisted of showing students rows of animals of differing sizes on the page and having them state whether the animal is big or small in real life. The Visual Selective Attention subtest consisted of two pages of randomly placed numerals (1–9). On the first page, students were required to underline only numerals 1, 2 and 3. On the second page, students were asked to switch to finding only numerals 4, 5, and 6. The final subtest, Receptive Attention, required students to underline sets of matching pictures, first identical images, and then pictures of things of the same category or "name." Based on the descriptions of the subscales, it can be seen that the CAS Attention Subtest required "the child to focus on a task, selectively attend to a specific stimulus, and suppress irrelevant stimuli" (Naglieri & Das, 1997b). Additionally, children needed to sustain focus to score well. Thus the assessment aligns well with the general attributes of attention models previously described.

DATA ANALYSIS AND RESULTS

A *t*-test for independent samples and a factorial ANOVA were employed in the data analyses. Alpha

was set at .05 for all tests. Assumptions of normal distributions and homogeneity of variances were met. To test for initial equality of groups, a *t*-test for independent samples was used to analyze pretest scores (See Table 2). The test was not significant ($t = 1.11$, df $= 66$, $P = .27$). Gain scores were then computed for each child by subtracting the pretest score from the posttest score (See Table 3). This variable became the dependent variable in a 2×2 factorial ANOVA with group (experimental and control) and sex as the two factors. The analysis of variance revealed no significant main effects for group or sex, but a significant interaction. See Table 4 for the results of the ANOVA and Figure 2 for a depiction of the significant interaction. Partial eta-squared effect sizes are included in Table 4. The group×sex interaction accounted for 9% of the variance in the model which is considered a medium effect size (Cohen, 1988).

DISCUSSION

The significant group×sex interaction raises interesting questions about how best to improve attention in kindergarten children. When the interaction was discovered, classroom records were immediately reviewed to see if females had completed more boxes than males. The number of boxes each child completed had been tallied in the experimental classrooms. Review of these records showed no difference between the sexes. This makes sense since the children were given the boxes to use for 15 minutes each day as part of the daily classroom routine and were checked off after completion of each box. Although neither experimental teacher had noticed that females chose to use the materials during free choice time more than males, additional control of this variable through controlled observation is warranted in the future.

Table 2. Experimental and Control Group Means, Standard Deviations[a], and Confidence Intervals

Group	*N*	Pretest	Posttest	Gain	95% Confidence Interval for Gain Score	
					Lower Bound	Upper Bound
Experimental	36	108.1 (11.9)	110.7 (13.9)	2.6 (9.2)	−.5	5.7
Control	32	105.1 (10.4)	103.8 (8.8)	−1.3 (12.0)	−5.6	3.1

[a] Standard deviations in ( )

Table 3. Experimental and Control Group Means, Standard Deviations[a], and Confidence Intervals by Sex

Group	Sex	*N*	Pretest	Posttest	Gain	95% Confidence Interval for Gain Score	
						Lower Bound	Upper Bound
Experimental	F	23	109.4 (11.4)	113.7 (13.2)	4.4 (10.1)	−.02	8.7
	M	13	106.0 (13.0)	105.5 (14.2)	−.5 (6.8)	−4.6	3.6
Control	F	11	111.5 (8.6)	104.8 (9.0)	−6.6 (11.0)	−14.0	.7
	M	21	101.8 (9.9)	103.3 (8.9)	1.5 (11.9)	−3.9	6.9

[a] Standard deviations in ( )

Table 4. Analysis of Variance for Gain Scores

Source	df	*F*	Partial η^2
Corrected Model	3	2.92*	.12
Group	1	2.89**	.04
Sex	1	.39	.01
Group×Sex	1	6.19*	.09
Error	64	(106.25)	

Note: Value enclosed in parentheses represents mean square error
* $P < .05$, ** $P < .10$

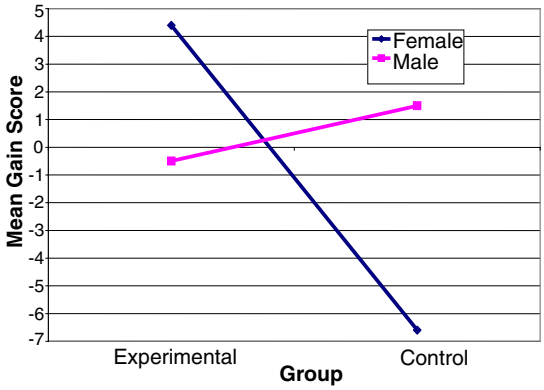

Fig. 2. Graph depicting the interaction of treatment and sex

To better understand the findings that female, but not male attention, was increased through the use of the materials, brief follow-up interviews were conducted with all of the students in the experimental group asking them their feelings concerning the boxes. An overwhelming majority of both male and female students expressed favorable reactions to using the materials. The children said they were fun and many chose to use them during free choice time in addition to the regularly scheduled time. Additionally, experimental group teachers reported that the students enjoyed the activities, looked forward to getting new ones each week, and often chose to work with the boxes during free choice time. Rule and Stewart (2002) reported similar findings of student enjoyment of the activities.

Given that the interviews revealed that both boys and girls liked the boxes, the group×sex effect was all the more interesting. Future research should experiment with different activities that might be more effective for boys. It could be that the contents of the boxes were gendered in favor of female likes and needs, or perhaps the nature of the activities themselves (e.g., handling and manipulating spoons, tweezers, etc.) aligned better with females.

One thing about the control condition performance over time needs to be highlighted. The substantial drop in attention scores for control females, when during the same period of time experimental females made substantial gains, is cause for concern. If future research replicates this finding, then a strong rationale would emerge for systematic fine motor skill activities for kindergarten females. The challenge, however, would remain to find a similar efficacious treatment for boys.

Finally, three potentially confounding variables need to be mentioned. First, time spent on fine motor activities may have varied in these classrooms. Teachers were surveyed about how much time they spent on such activities and no appreciable differences were found, but more systematic controls need to be instituted in future research to eliminate the potential for time to confound the treatment. Ideally, future research would involve competing types of fine motor skill activities along with a control condition with amount of time spent on fine motor skill activities more tightly controlled. Second, both choice and interest have been found to be important to attention (Lillard, 2005). Providing interesting activities, choice in activities, and choice in how to complete activities improve children's persistence and thus attention to the task. However, the transfer of these effects to other non-target tasks has not been established. In other words, when children are given choice or are exposed to interesting activities, they do persist longer and attend more to that particular activity, but whether or not this causes their attention capability to grow and transfer to other settings has not been established. Thus, it could be that the choice provided by the variety of activity boxes available to the children was the causative agent in females' increase in attention. The same could be said about interest. It might be that the activity boxes were of great interest to the children, and thus it was the causative agent for the effect. Of course, the cause could be the result of a combination of all three variables (i.e., fine motor practice, choice, and interest) or some combination of two of them. Future research is needed to ascertain the causative agent or agents.

This study has revealed some interesting and intriguing findings that warrant further research, especially given the important role attention plays in child development and academic achievement. Developing fine motor activities that are as effective for males as females is one avenue for future research along with refining our knowledge of the particular causal agent or agents.

REFERENCES

Alexander, K. L., Entwisle, D. R., & Dauber, S. L. (1993). First-grade classroom behavior: Its short- and long-term consequences for school performance. *Child Development*, *64*, 801–814.

Barkley, R. A. (Ed.) (2006). *Attention-deficit/hyperactivity disorder: A handbook for diagnosis and treatment* (3rd ed.). New York: Guilford.

Butler, R. W., & Copeland, D. R. (2002). Attentional processes and their remediation in children treated for cancer: A literature

review and the development of a therapeutic approach. *Journal of the International Neuropsychological Society*, *8*, 115–124.
Cohen, J. (1988). *Statistical power analysis for the behavioural sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.
DuPaul, G. J., & Stoner, G. (2003). *ADHD in the schools: Assessment and intervention strategies* (2nd ed.). New York: Guilford.
Honig, A. S. (2006). What infants, toddlers, and preschoolers learn from play: 12 ideas. *Montessori Life*, *18*(1), 16–21.
Howse, R. B., Lange, G. L., Farran, D. C., & Boyles, C. D. (2003). Motivation and self-regulation as predictors of achievement in economically disadvantaged young children. *The Journal of Experimental Education*, *71*(2), 151–174.
Lillard, A. S. (2005). *Montessori: The science behind the genius*. New York: Oxford University Press.
Lubienski Wentworth, R. A. (1999). *Montessori for the new millennium*. Mahwah, NJ: Lawrence Erlbaum Associates.
McCormick, C. C., & Schnobrich, J. N. (1971). Perceptual-motor training and improvement in concentration in a Montessori preschool. *Perceptual and Motor Skills*, *32*, 71–77.
McCormick, C. C., Schnobrich, J. N., Footlik, S. W., & Poetker, B. (1968). Improvement in reading achievement through perceptual-motor training. *Research Quarterly*, *39*, 627–633.
McCormick, C. C., Schnobrich, J. N., & Footlik, S. W. (1969). The effect of perceptual-motor training on reading achievement. *Academic Therapy Quarterly*, *4*, 171–176.
Merrell, C., & Tymms, P. (2003, April). *Rasch analysis of inattentive, hyperactive and impulsive behaviour in young children and the link with academic achievement*. Paper presented at the annual meeting of the American Educational Research Association, Chicago, IL. (ERIC Document Reproduction Service No. ED476136).
Naglieri, J. A., & Das, J. P. (1997). *Cognitive assessment system*. Itasca, IL: Riverside.
Naglieri, J. A., & Das, J. P. (1997b). *Das-Naglieri cognitive assessment system*. Retrieved Saturday, January 20, 2007 from the Mental Measurements Yearbook database.
Penkman, L. (2004). Remediation of attention deficits in children: A focus on childhood cancer, traumatic brain injury and attention deficit disorder. *Pediatric Rehabilitation*, *7*(2), 111–123.
Rule, A. C., & Stewart, R. A. (2002). Effects of practical life materials on kindergartners' fine motor skills. *Early Childhood Education Journal*, *30*(1), 9–13.
Sobe, N. (2004). Challenging the gaze: The subject of attention and a 1915 Montessori demonstration classroom. *Educational Theory*, *54*(3), 281–297.
Sohlberg, M., & Mateer, C. (1987). Effectiveness of an attention training program. *Journal of Clinical and Experimental Neuropsychology*, *9*, 117–130.
Sohlberg, M., & Mateer, C. (1987). *Attention Process Training (APT)*. Washington, DC: Association for Neuropsychological Research and Development.
Sohlberg, M., Johnson, L., Paule, L., Ruskin, S., & Mateer, C. (1994). *Attention Process Training-II (APT-II)*. Washington, DC: Association for Neuropsychological Research and Development.
Standing, E. M. (1984). *Maria Montessori: Her life and work*. New York: Penguin.
Thomson, J., & Kerns, K. (2005). *Pay Attention! Attention training for children ages 4–10*. Retrieved January 27, 2007 from http://www.lapublishing.com/detail.asp_Q_product_id_E_PA-YAT_A_Contents_E_Excerpts.
Thomson, J., Kerns, K., Seidenstrang, L., Sohlberg, M., & Mateer, C. (2001). *Pay Attention! A children*'s attention process training program. Wake Forest, NC: Lash & Associates.
Travers, R. M. W. (1985). *Training human intelligence: Developing exploratory and aesthetic skills*. Holmes Beach, FL: Learning Publications.
Warner-Rogers, J., Taylor, A., Taylor, E., & Sandberg, S. (2000). Inattentive behavior in childhood: Epidemiology and implications for development. *Journal of Learning Disabilities*, *33*(4), 520–536.
Wittrock, M. C. (1986). Students' thought processes. In Wittrock, M. C.(Ed.), *Handbook of research on teaching* (3rd ed., pp. 297–314). New York: McMillan.
Woods, C. S. (2000). The cycle of movement. *Montessori Life*, *12*(4), 21–23.