Impact of a Movement Program on Preschoolers' Perceptual-Motor Abilities

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Abstract
The purpose of the study was to investigate the impact of a 6-week preschool movement program on the perceptual-motor abilities of preschoolers. The study utilized a one-group pretest-posttest design, followed by retention tests. Participants included 37 preschoolers (17 boys and 20 girls) from two early childhood development centers in mid-western United States. The movement program focused on the following: visual memory, response time, eye-hand coordination/hand steadiness, and agility. It consisted of six sessions (one per week) each lasting 40 minutes. The Visual Memory Test (VMT), Response Time Test (RTT), Rotary Pursuit Task (RPT), and Shuttle Run Test-Preschool (SRT-P) served as the main data sources. One-Way Repeated Measures ANOVA indicated significant effects for all four tests. Bonferroni follow-up comparisons showed that the mean scores for all four posttests were significantly better than those for the pretests. Only the retention mean score for SRT-P differed significantly from the pretest. The results suggest the variables measured are trainable in the preschool population.

Keywords: Perceptual-motor abilities, preschoolers, movement program.

1.0 Introduction

The early years are crucial in determining future development of the child. It is necessary to cater to the overall development of children of this age-group (National Association for the Education of Young Children [NAEYC], 2008). Physical development is the most neglected domain in preschool settings (Stork &Sanders 2008). Unarguably, early childhood is the ideal time for acquiring fundamental motor skills, because it is during this period that children build the basic movement abilities that are the foundation for learning more complex movement skills later in life (Pica, 2011). Participation in regular movement and physical activity can help in reducing the prevalence of childhood obesity and overweight and improve academic performance. Research has shown the benefits of movement competence among young children and strategies to enhance programs that develop their fundamental motor skills (see for example Robinson, Webster, Logan, Lucas, & Barber, 2012). Therefore, not only should teachers of young children understand the benefits of physical activity, but they should incorporate movement programs into their curriculum on a daily basis (Sanders, 2002).

The school provides the sole opportunity for a large proportion of children in industrialized societies to accrue moderate to high intensity physical activity (Trudeau & Shephard, 2005). Fundamental motor skills are important building blocks for more complex movement and sport skills (Gallahue, Ozmun, & Goodway, 2012). Early perceptual-motor development plays an important role in emotional, social, cognitive, academic and adaptive development (Piek, Dawson, Smith, Gasson, 2008; Cairney, Veldhuizen, Szatmari, 2010). Shim, Norman, and Kim (2013), for example, demonstrated the use of balancing activities to reinforce and assess children's cognitive development. Perceptual deficits can influence learning abilities, especially in early stages of the education process (Kulp. Cline, Wheeler, Loraine, 2004). Goodway and Branta (2003) demonstrated that a twice-weekly motor development and physical activity sessions across 12 weeks improved preschoolers' locomotor and object control skills. Moreover, the improvements in motor skills can be attained without sacrificing learning time in other content areas. There is evidence showing that integrating movement into curriculum activities can increase activity levels of preschoolers without sacrificing academic learning time (Trost, Fees, & Dzewaltowski, 2008).

Research indicates that children with disabilities do also benefit from motor skill interventions. Apache (2005) reported a sample of preschoolers' with developmental delays improved their locomotor and object control skill levels after participating in a 15-week activity-based motor skill intervention program.

Despite the beneficial outcomes of physical activity— and the importance of physical development of the child (Wright & Stork, 2013), often early childhood educators are unaware of movement-related teaching strategies, and frequently utilize inappropriate practices in teaching movement (Burgeson, Wechsler, Brener, Young, & Spain, 2001). Movement interventions among preschoolers have focused on locomotor and object control skills. Interventions targeting perceptual-motor abilities among preschoolers are scarce. It is important to understand the extent to which perceptual-motor abilities are trainable in this population. Only then would early childhood educators, through professional development, be equipped to provide developmentally and instructionally appropriate movement programs (Copple & Bredekamp2009).

1.1 Purpose of the Study

Perceptual-motor abilities are highly related to the successful performance of several movement skills (Gallahue et al., 2012). Children who are most coordinated would likely be more active than those who are less coordinated (Fisher et al., 2005). Therefore, the purpose of the present study was to investigate the impact of a 6-week preschool movement program on the perceptual-motor abilities of preschoolers. Specifically, it attempted to determine the extent to which the program would improve preschoolers' performances on the Visual Memory Test (VMT), Response Time Test (RTT), Rotary Pursuit Task (RPT), and Shuttle Run Test-Preschool (SRT-P). Findings from the study would help identify effective strategies for the implementation of perceptual-motor instruction in a preschool setting. These strategies would in turn assist care givers to guide preschoolers develop and maintain perceptual-motor abilities.

1.2 Research Questions

Four research questions underpinned the study:

1. What are the associations among age and selected perceptual abilities among a sample of preschoolers?
2. To what extent do male and female preschoolers' performances on selected perceptual-motor abilities differ?
3. What is the impact of a six-week movement program on the perceptual motor abilities of a group of preschoolers?
4. To what extent would a group of preschoolers retain improvements on their perceptual-motor abilities as a result of a six-week movement program?

2.0 Method

The study utilized the one-group pretest-posttest design. Retention tests were conducted four weeks after the posttests to determine the extent to which gains from the movement program were retained.

2.1 Participants and Context

Thirty-seven preschoolers (17 boys and 20 girls) 3-5 years old (M = 4; SD = .67) participated in the study. Participants were enrolled in two university-based early childhood development centers in mid-western United States. One site consisted of 19 preschoolers and the other 18. Thirty (81.08%) of the preschoolers were Caucasian, while four (10.81%) and three (8.11%) were Asian and African-American respectively.

2.2 Intervention

A six-week preschool movement program served as the intervention. The program focused on the following: visual perception, response time, eye-hand coordination/hand steadiness, and agility. It consisted of six sessions (one per week) each lasting 40 minutes. Each session included a 4-minute "interaction" time at the beginning and at the end, and a 32-minute perceptual-motor instruction. The "interaction" time was intended for the preservice physical education teachers (PPET) who implemented the program to get to know the preschoolers and for warm-up and cool-down.

The perceptual-motor instruction segment consisted of time for explaining the activities, teaching the critical cues and allowing participants to practice. Participants were divided into four groups of 4-5. Each group rotated among four stations comprising learning experiences in visual memory, response time, eye-hand coordination/hand steadiness, and agility. Thirty-one (18 males and 13 females) PPETs, enrolled in a middle school methods course, implemented the movement program under the supervision of their course instructor. The PPETs had already taken courses in elementary physical education methods and motor development/learning. The movement program was conducted in a large gymnasium at the university where the early childhood centers were based.

2.3 Instruments

Visual memory, response time, eye-hand coordination/hand steadiness, and agility were assessed with the VMT, RTT, RPT, and the SRT-P—the tests had test-retest reliabilities of .679, .648, .630, and .872 respectively. Participants had practice trials on each test prior to doing the test trials. The VMT required participants to respond to three pegboard tasks. An appropriate response for each task was scored as "1" and an inappropriate response as "0." Thus, the overall VMT score for each participant ranged from 0 to 3.

In the RTT, shapes (circle, triangle, and rectangle) were randomly displayed on a computer screen one at a time. The objective of the test was for a participant, using a computer mouse, to click on the image as quickly as possible. The images were displayed at variable intervals to avoid anticipation by the participants. After clicking on five images, the program automatically calculated the mean of the five trials. The participant repeated three sets of trials. A participant's score was the mean of the best three sets of trials.

The RPT photoelectric rotary pursuit apparatus (Lafayette Instrument Model 30014A) consisted of a wand connected by a cord to a turntable-like base unit, which is placed on a tabletop. The base unit emits a light source beneath a clear glass top in a circular pattern, and in a clockwise direction. The turntable was set at 25 revolutions per minute (rpm), and with a sensitivity of 9. The test time for each revolution was five seconds, with a four-second rest interval. Each test cycle consisted of four revolutions with a possible maximum score of 20 seconds of time on target.

Participants were instructed to maintain the tip of the wand over the circling light source as long as possible without the tip of the wand contacting the glass surface. At the end of each test cycle, a participant obtained a score for the time the stylus was on target. The mean of two trials served as a participant's score.

The SRT-P required the participant to run back and forth as quickly as possible between two lines 12 feet apart. From a start line, the test taker runs to the other line, picks up a wooden block and places it on the start line. Then quickly runs back and picks the second wooden block and places it on the start line. The quicker of two trials served as the participant's score.

Pretests and posttests for the four dependent variables were conducted in a large motor development lab, one week before and after the movement program. Retention tests were conducted four weeks after the posttests.

2.4 Data Analysis

Data were analyzed using descriptive and inferential statistics. First, Pearson correlation coefficients were calculated to determine the relationships among age, VMT, RTT, RPT, and SRT-P. Second, the authors conducted t-Test analyses to compare the VMT, RTT, RPT, and SRT-P mean scores for male and female preschoolers. The pretest data were used to calculate the correlation coefficients and the t-statistics.

Third, a One-Way Repeated Measures ANOVA was calculated (alpha level = .05) comparing the test scores of the participants at three different times— pretest, posttest, and retention tests.

3.0 Results

3.1 Correlations among Age and Perceptual-motor Tests

The first research question examined the associations among age and selected perceptual abilities. Table 1 presents data on the correlations among age, VMT, RTT, RPT, and SRT-P. The matrix shows that age had a significant positive correlation with RPT (higher scores indicated better performance), and negative correlations with RTT and SRT-P (lower scores indicated better performance). Conversely, age was not significantly related to VMT.

3.2 Perceptual-motor Tests and Gender

The second research question investigated the extent to which male and female preschoolers' performances on the perceptual motor ability tests differed. Table 2 presents data on gender, VMT, RTT, RPT, and SRT-P. Results indicated the RTT mean scores for males and females differed significantly. The males (2.14) scored significantly higher than the females (1.46). Alternatively, performances of the male and female preschoolers on VMT, RPT, and SRT-P did not differ significantly. Even though not significant, the males had a higher mean score on SRT-P while the females had a higher mean score on the RPT. The VMT mean scores for both groups were identical.

3.3 Impact of Movement Program on Perceptual-motor Tests

The first research question investigated the extent to which the intervention impacted preschoolers' performances on the perceptual-motor ability tests. The data are presented in Table 3. The results indicated significant effects for all four tests— VMT ($F = 8.28$; $p = .001$), RTT ($F = 5.70$; $p = .005$), RPT ($F = 14.64$; $p = .000$), and SRT-P ($F = 52.73$; $p = .000$). Bonferroni post-hoc analyses showed that the mean scores for the posttests were significantly better than those for the pretests. Mean scores for VMT improved from pretest (2.54) to posttest (2.96), RTT from pretest (2.90) to posttest (2.30), RPT from pretest (1.75) to posttest (1.38), and SRT-P from pre-test (11.71) to posttest (9.95).

3.4 Retention of Gains from Movement Program

Table 3 presents data on retention test scores for the four measures. The Bonferroni post-hoc analyses showed no significant differences between the mean scores for the posttests and retention tests for VMT, RTT, and RPT. In contrast, there was a significant mean difference between the posttest and retention test for SRT-P. The SRT-P mean score for the posttest was better than that for the retention test, indicating that participants could not retain the gains four weeks after the intervention.

4.0 Discussion and Conclusions

A major finding of the present study is that the movement program resulted in significant improvements in preschoolers' performance on the VMT, RTT, RPT, and SRT-P. This implies the measured variables— visual memory, response time, eye-hand coordination/hand steadiness, and agility— are trainable among preschoolers. This is consistent with the results of other interventions that reported improvements in preschoolers' motor competence (Goodway & Branta, 2003; Robinson et al., 2012). In light of the relationship between perceptual-motor abilities and motor skills (Gallahue et al., 2012), it is critical that early childhood educators provide quality movement programs to prepare preschoolers to learn fundamental motor skills later.

A second finding was that age was significantly correlated with RTT. This may be age-related rather than age-dependent (Gabbard, 2008). A plausible reason could be that older participants had more prior experience with the tasks than the younger participants. This is consistent with previous research that reported a significant correlation between age and handwriting speed among school-aged children (Tseng & Chow, 2000). Also, the finding in the current study that age was not significantly correlated with visual memory is consistent with Tseng and Chow's (2000) finding. The authors reported a non-significant correlation between age and visual memory.

The mean scores for the retention tests for VMT, RTT, RPT, showed participants' performances declined during periods of non-practice after the posttests, even though these were not statistically significant. However, the results indicated that the preschoolers' performances on the SRT-P declined significantly four weeks after cessation of practice. The detraining effect on agility seems to be more notable than any detraining effect on visual memory, response time, and eye-hand coordination/hand steadiness. This decline in performance is more likely due to metabolic effects (i.e. peripheral) than to neuromuscular factors (i.e. central) simply because these factors reverse faster than neuromuscular factors. The half-life of anaerobic enzymes is very short and the period where no instruction was given likely resulted in loss of these enzymes and a decline in performance (Brooks, Fahey, &Baldwin, 2005). The implication would be that agility training must be introduced and repeated more frequently than the visual motor tasks.

The findings in this study have implications for teaching and teacher education. First, it is possible for early childhood caregivers, through professional development activities, to impact preschoolers' perceptual-motor abilities through movement instruction. Second, it provides evidence to support regular movement activities for preschoolers in order to sustain any gains that would accrue from participation in such programs. Finally, it is important for teacher educators to help physical education and early childhood education preservice teachers make the connection between theory and practice to enhance the implementation of movement programs. This is particularly crucial for physical education preservice teachers as many school districts in the United States are making preschools part of formal schooling.

Physical education preservice teachers implemented the intervention in the present study. Future research should investigate the extent to which early childhood educators would impact preschoolers' perceptual-motor abilities through movement programs. This would be insightful since research shows that early childhood educators frequently utilize inappropriate practices in teaching movement (Burgeson et al., 2001). As Grause (2011, P. 15) rightly pointed out, ". . . learning content is inherently intertwined with other elements like motor skills aesthetic experiences, and social-emotional development." That is, being responsible for the education of young children on a daily basis, it is imperative that early childhood educators provide quality movement instruction as part of the total development of their students. Likewise, it is imperative that movement instruction be instituted as a co-curricular activity to enhance learning in other academic areas.

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Table 1: Correlation matrix for age and perceptual-motor tests

Category	1	2	3	4	5
1. Age		.307	-.467*	.637**	-.529**
2. Visual Memory			-.194	.364	-.503**
3. Response Time				.653**	.577**
4. Rotary Pursuit Task					-.630**
5. Shuttle Run Test					

*p < 0.05; **p < 0.01

Table 2: t-Test analyses for perceptual-motor tests and gender

Category	Males		Females		t-Value	
	M	SD	M	SD	T	P
Visual Memory Test	2.73	46	2.71	.69	.090	.929
Response Time Test	2.14	.86	1.46	.49	2.476	.022*
Rotary Pursuit Task	2.00	1.89	2.41	1.12	-.688	.498
Shuttle Run Test	11.82	2.13	10.94	1.77	1.185	.247

*p < 0.05

Table 3: One-Way Repeated ANOVA for perceptual-motor tests

Category	Pretest		Posttest		Retention Test		Repeated Measures ANOVA		Significant Contrasts
	M	SD	M	SD	M	SD	F	p	
Visual Memory	2.54	.65	2.96	1.96	2.85	.37	8.28	.001	2>1
Response Time	1.75	.70	1.38	.54	1.39	.51	14.64	.000	2>1; 3>1
Rotary Pursuit Task	2.90	1.49	2.30	1.41	2.80	1.51	5.70	.005	2>1
Shuttle Run Test	11.71	2.06	9.95	2.12	11.26	2.01	52.73	.000	2> 3>1

2>1 posttest score better than pretest score
3>1 retention score better than pretest score
2> 3 posttest score better than retention score