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INFLUENCE OF CUP STACKING ON HAND-EYE COORDINATION AND REACTION TIME OF SECOND-GRADE STUDENTS[1]

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Summary.—Cup stacking has been adopted recently by many physical education programs to enhance rudimentary motor skills such as hand-eye coordination and ambidexterity as well as quickness and concentration; however, no empirical evidence has been published to support these claims. We examined the influence of cup stacking on hand-eye coordination and reaction time of 24 boys and 18 girls in second grade as measured by the Soda Pop and Yardstick tests, respectively. Two physical education classes were randomly assigned as treatment and control groups and were pre- and posttested for hand-eye coordination and reaction time. The treatment group participated in a 5-wk. cup-stacking program. Significant improvements were noted for both hand-eye coordination and reaction time between the pre- and posttest scores for this group but not for the control group. Therefore, cup stacking is indeed effective in enhancing hand-eye coordination and reaction time.

The National Association for Sport and Physical Education (NASPE) stated that one of the major purposes of physical education is to develop movement competency and proficiency in students (NASPE, 1995). Movement competency was defined by NASPE as "the development of sufficient ability to enjoy participation in physical activities and establishes a foundation to facilitate continued motor skill acquisition and increased ability to engage in appropriate motor patterns in daily physical activities" (p. 2). For a student to become competent in movement, basic proficiency must be attained in fundamental motor skills, e.g., running, striking, catching. Keys to developing these skills, especially object-manipulation skills, are hand-eye coordination and reaction time.

Many physical educators incorporate a variety of activities into their curricula to enhance their students' basic movement competencies. One popular activity in schools today is cup stacking. The sport of cup stacking originated as a recreational activity offered in settings such as boys' and girls' clubs, after school programs, and community recreation facilities some 20 years ago. Since then, cup stacking has evolved into a nationally prominent

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sport, being taught in every state and well over 3,000 schools across the nation.

Anecdotal evidence in a brochure (Speed Stacks©, Castle Rock, CO, 2002), indeed suggested the efficacy of cup stacking in the acquisition and enhancement of basic motor skills; however, no empirical evidence is available to support these claims. A review of literature on the topic yielded only one study involving cup stacking, but it used cup stacking as an activity to measure the effectiveness of motivation and feedback and did not examine the effect of cup stacking on motor skills directly (Fredenburg, Lee, & Solomon, 2002). The purpose of this study was to examine the influence of cup stacking on hand-eye coordination and reaction time via the Soda Pop and Yardstick tests.

Method

Setting

We conducted this study in a public elementary school located in the central western part of the USA. All testing and training was held in the elementary school's gymnasium, multipurpose room, or library. The Human Subjects Committee of our college approved the research protocol and informed consent forms.

Participants

Forty-two second-grade students (24 boys, 18 girls) from two different physical education classes participated. The intact classes were randomly assigned as either the control ($n=21$; 12 boys; 9 girls; mean age=7.8 yr. (0.6); 18 right-hand dominant) or treatment group ($n=21$; 12 boys; 9 girls; mean age=7.8 yr. (0.4); 17 right-hand dominant). Signed parental consent forms were secured for each participant.

Procedure

Each participant initially completed the Soda Pop and Yardstick tests (we chose these tests because of their ease of administration and replication) to measure hand-eye coordination and reaction time, respectively (Hoeger & Hoeger, 2004). During the pretesting participants reported to the school's multipurpose room during their regularly scheduled physical education class. Upon arrival they were randomly assigned a test administrator and were administered the Soda Pop and Yardstick tests for the dominant hand (the hand the participant used for writing) and then for the nondominant hand.

Soda Pop Test

The Soda Pop test is a documented test of hand-eye coordination (Hoeger & Hoeger, 2004). The test involves constructing a cardboard platform 32 in. (81.28 cm) in length and 5 in. (12.7 cm) wide. Six circles, 3.25 in.

training for both the dominant and nondominant hands ($F = 12.69$, $p = .0006$; $F = 24.93$, $p < .0001$, respectively). For the control group, no significant differences were observed between the pretraining and posttraining Yardstick test scores for both the dominant and nondominant hands ($F = 0.01$, ns; $F = 0.60$, ns, respectively). The posttraining Yardstick test scores for the treatment group were significantly lower than the posttraining Yardstick test scores for the control group for the dominant and nondominant hands ($F = 33.1$, $p < .0001$; $F = 25.94$, $p < .0001$, respectively); see Table 1.

Discussion

A review of related literature on cup stacking showed no previous research published on the efficacy of cup stacking in motor skill acquisition and performance. Therefore, the purpose of our study was to examine the influence of cup stacking on hand-eye coordination and reaction time of second-grade students as measured by the Soda Pop and Yardstick tests, respectively, following a 5-wk. cup-stacking unit in a physical education course.

Coordination is defined as "the integration of the nervous and the muscular systems to produce correct, graceful, and harmonious body movements" (Hoeger & Hoeger, 2004, p. 256), and "reaction time is defined as the time required to initiate a response to a given stimulus" (p. 258). These were our operational definitions. Specifically, though, we measured hand-eye coordination through the Soda Pop test and reaction time (technically total time) via the Yardstick test as recommended by Hoeger and Hoeger (2004). Our results, nevertheless, should not be construed to relate to these factors as global constructs; rather, our results are indicative of improvements in the performed tests that may perhaps influence related activities.

Our results indicate that cup stacking positively influenced scores on tests to measure hand-eye coordination and reaction time in these second-grade students. These findings are important to the physical educator because hand-eye coordination and reaction time are essential elements in many movement forms and motor skills and tie directly into the national standards for physical education (NASPE, 1995). Specifically, the basic development and mastery of these skills allows one to engage productively in additional motor skill development, designed to increase overall motor skill proficiency and facilitate participation in a variety of lifetime sporting and fitness-related activities.

Physical education curricula should contain numerous meaningful experiences to help a student become physically educated (NASPE, 1995). Basic motor skills must be developed for a student to become proficient in movement, and many activities require the fundamental development of hand-eye coordination and reaction time. Physical educators have used a variety of traditional activities, e.g., catching, striking, dribbling, to develop hand-eye co-

Data Analysis

The Soda Pop test scores in seconds and the Yardstick test scores in inches were evaluated for main effects of group and testing time and group by testing time interactions using a two-way analysis of variance with repeated measures, 2 (group) × 2 (test session). Tukey *post hoc* tests were completed to evaluate significance of interactions in the initial analysis of variance. Standard *t* tests were applied to test differences in demographic and performance characteristics between the control and treatment groups. Statistical significance was accepted at the .05 alpha.

Results

Forty-one participants completed both the pre- and posttests (one participant did not complete the posttest because a family moved). No significant differences were observed between the control and training groups with respect to age, sex, hand dominance, or pretraining Soda Pop and Yardstick test scores ($p > .05$).

Soda Pop Test

The results of the Soda Pop test are shown in Table 1. The treatment group's posttraining Soda Pop test scores significantly improved from the pretraining scores for both the dominant and nondominant hands ($F = 26.93$, $p < .0001$; $F = 37.82$, $p = .0001$, respectively). The pre- and posttraining Soda Pop test scores for the control group's dominant ($F = 0.30$, ns) and nondominant ($F = 0.01$, ns) hands were not significantly different. With respect to the posttraining Soda Pop test scores, the treatment group's scores were significantly lower than the control group's for the dominant and nondominant hands ($F = 21.71$, $p < .0001$; $F = 37.28$, $p < .0001$, respectively).

TABLE 1
Soda Pop and Yardstick Tests Pre- and Posttest Scores For Control and Treatment Groups

Test	Control ($n = 21$)				Treatment ($n = 20$)			
	Pretest		Posttest		Pretest		Posttest	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Soda Pop Test, sec.								
Dominant hand	16.0	2.2	15.6	2.2	17.6	3.9	12.5	2.1*
Nondominant hand	17.4	2.6	17.5	2.5	19.0	3.7	13.2	2.0*
Yardstick Test, in.								
Dominant hand	11.1	2.6	11.0	2.5	10.7	1.8	7.4	1.3*
Nondominant hand	10.5	2.4	11.1	2.5	11.0	2.4	7.9	1.3*

*Denotes significant difference at $p \leq .05$ between treatment pre- and posttest values.

Yardstick Test

The treatment group's Yardstick test scores significantly improved after

(8.26 cm) in diameter, are drawn centered on the cardboard 1.5 in. (3.81 cm) apart. Three full soda pop cans are used for the test and are placed in every other circle starting from the side of the hand being tested. The participant begins the test by placing the hand "thumb up," with the elbow joint bent about 100–120°, grasping the can with the hand being tested. On the signal of the tester saying "Go," the stopwatch is started and the participant begins. Each can is then turned upside down into the adjacent empty circle within the drawn line. The participant then returns to the first can turned, replaces it in the original position and proceeds with the other two cans. This whole process is repeated twice. The time of each test is recorded to the nearest tenth of a second. The participant is given two practice trials.

Yardstick Test

The Yardstick test is an established test for measuring reaction time (Hoeger & Hoeger, 2004) [technically it measures total time or reaction time plus movement time]. It involves taking a standard "yardstick" and shading in the first 2 in. with a light-colored marker as a "concentration zone." The participant sits in a chair, resting one hand on the edge of a table with the thumb and fingers about 1 in. apart and extended 3 in. off the table. The test administrator holds the yardstick in a vertical position, with the flat edge of the yardstick parallel to the palm of the hand and even with the top of the thumb and index finger. The test administrator then gives the command "ready," makes a random 1- to 3-sec. silent count, and releases the yardstick. The participant grabs the yardstick with the fingers and thumb as quickly as possible without moving the hand from its initial starting point. The trial is scored to the nearest 1/2 in., measured above the top of the thumb. Three practice trials are given, and 12 trials are performed during the actual test. The three fastest and three slowest times are eliminated, and the middle six times are averaged to attain a final score.

After pretesting, the treatment group was given basic instructions on the proper mechanics and sequencing of cup stacking shown in the brochure (Speed Stacks©, Castle Rock, CO, 2002). The treatment group then completed 20 30-min. cup-stacking sessions (approximately 4 per week), using both hands, which were incorporated into their regular physical education class over 5 wk. The instruction and progression of cup stacking began with a basic three stack and progressed to more complicated stacks. During the training sessions for cup stacking, a number of physical activities, e.g., running relays, scooters, were incorporated into the lessons to maintain participants' interest. The control group participated in other regularly scheduled activities, e.g., jump rope, parachute, during this same period. At the conclusion of the 5-wk. training period, every participant was again administered the Soda Pop and Yardstick tests.

ordination and reaction time over the years (Thomas, Lee, & Thomas, 2000). Such motor skills are necessary requisites for development. Thus the results of this study indicate that cup stacking might be a valuable component of the physical education curriculum and is a viable activity for the development of hand-eye coordination and reaction time. It would be desirable to extend this study with a larger sample of elementary school students as no power assessment was done here and *n*s were not large and from one location.

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