

A PILOT STUDY OF A POSSIBLE EFFECT FROM A MOTOR TASK ON READING PERFORMANCE¹

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Summary.—This pilot study examined the influence of participation in a 6-week bimanual coordination program on Grade 5 students' reading achievement. Twenty Grade 5 students participated in a bimanual activity (sport stacking) and were tested whether reading achievement scores were significantly different from the scores for 21 control students. The experimental group consisted of 20 students (11 boys, 9 girls) from one intact classroom cohort; the control group consisted of 21 students (12 boys, 9 girls) from one intact classroom cohort. Students in both groups ranged in age from 10 to 11 years. The intact classroom cohorts were randomly assigned to experimental and control groups. Reading achievement was measured by differences in pre- and posttest scores from the GMRT-4 Decoding and Comprehension skill subtests. Group by sex analyses of covariance, using pretest scores as covariates, indicated that there were no significant differences by group or sex for decoding skills. A significant increase was found for the experimental group on Comprehension skills. Therefore, participation in a bimanual coordination program, using sport stacking as the activity, may improve Grade 5 students' reading comprehension skills, regardless of sex.

Several studies have addressed the relationship of bimanual coordination and reading ability (Wolff, Cohen, & Drake, 1984; Gladstone, Best, & Davidson, 1989; Davidson, Leslie, & Saron, 1990; Wolff, Michel, Drake, & Ovrut, 1990; Moore, Brown, Markee, Theberge, & Zvi, 1995). The studies indicate that, in general, when compared to neurologically intact individuals, children and adults with impaired reading skills and dyslexia have slower and less accurate bimanual coordination. Furthermore, it has been suggested that variations in the dynamics of interhemispheric interaction may contribute to differences in reading ability (Wolff, *et al.*, 1984, 1990; Marion, 2002).

Given the findings relative to associations between bimanual coordination and reading skills, participation in activities designed to enhance bimanual coordination may prove beneficial to students' reading achievement (Hanaford, 1995, 1997; Jensen, 2000).

A relatively new activity being utilized by physical educators is sport stacking. Sport stacking is an activity that requires the participant to use both hands to stack a group of 12 specialized cups in predetermined combinations. Each participant works with their own set of cups, to gain competency

in stacking cups into the predetermined combinations. As the participant learns and is able to accurately perform the required cross-lateral movements that make up the patterns, the tasks become more complex and expand to include an emphasis on speed of performance.

Research has shown that both hemispheres of the brain are activated when college students speed stack (Hart & Bixby, 2005). While studies have supported potential improvements in reaction time and hand-eye coordination in Grade 2 boys and girls (Udermann, Murray, Mayer, & Sagendorf, 2004), an association between sport stacking and academic performance has not been documented.

The purpose of this pilot study was to examine the influence of participation in a 6-week bimanual coordination program on Grade 5 students' reading achievement. The test here was whether children stacking cups for six weeks would increase their reading performance significantly more than children who did not.

METHOD

Participants

The participants were Grade 5 students from two classes in a K-8 parochial school in the mid-Atlantic region ($N=41$). The school represented students from the middle-to-upper socioeconomic classes. Ethnicity of the school was comprised of 74% Euro-American, 20% African-American, 3% Latino-American, 2% Asian-American, and 1% Native American students.

Participants included in the data collection were those who had a signed consent form from parents or guardians, took both pre- and posttests for reading achievement, and were absent two or fewer times for the intervention sessions. Participants were grouped as a classroom cohort; one cohort was randomly assigned to the experimental group while one cohort was randomly assigned to the control group. The experimental group consisted of 20 participants (11 boys, 9 girls). The control group consisted of 21 participants (12 boys, 9 girls).

Materials

Reading achievement.—Reading achievement was assessed using the group administered Gates-MacGinitie Reading Test Fourth Edition (GMRT-4), which is designed to measure reading decoding and comprehension skills. Participants were pre- and posttested using Level 4 Form S; this level was selected as appropriate since the study occurred at the beginning of the school year. The classroom teachers administered and scored both the pre- and posttests; the classroom teachers also coded each booklet with a numerical value to assure participants' anonymity. Administration of the GMRT-4 pretest occurred on the same day and at the same time.

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Reliability statistics for the GMRT-4 were calculated using Kuder-Richardson Formula 20. Reliability for Level 4 Form S was .92 for Decoding and .93 for Comprehension for the fall administration. Validity statistics for the GMRT-4 were calculated by correlation of the GMRT-4 with validity scores from the Gates-MacGinitie Reading Test Third Edition (GMRT-3). The correlation for Level 4 was .89 for Decoding and .86 for Comprehension. Validity statistics for the GMRT-3 were calculated by correlation with other reading tests. Validity of the GMRT-3 with the Iowa Test of Basic Skills (ITBS) and Tests of Achievement and Proficiency (TAP) ranged from .56 to .88. Correlation of the GMRT-3 with the Comprehensive Test of Basic Skills (CTBS) ranged from .74 to .84.

Activity questionnaire.—An activity questionnaire was distributed for completion by parents or guardians assessing participants' involvement in any or all of the following: (1) prior sport stacking opportunities, (2) bimanual activities other than sport stacking, such as playing of a musical instrument or playing video games, and (3) sports activities such as basketball or soccer. The activity questionnaires were distributed at the same time as the parents' and guardians' consent forms were distributed. The classroom teachers coded each returned activity questionnaire with a numerical value to assure participants' anonymity and to coincide with the number given for each participant for pre- and posttest scores.

Classroom teacher interview.—A classroom teacher interview was conducted for the purpose of assessing the type of reading instruction, quantity of time allocated to reading per day, and if any additional reading experiences occurred which may have affected the outcome of the pilot study. The classroom teacher for the experimental group was a man; the classroom teacher for the control group was a woman. The classroom teacher of the experimental class had 30 years teaching experience, but the teacher of the control class was in the first year of teaching. This disparity in teaching experience is a serious confounding factor in this pilot study. The lead author conducted all of the interviews at the conclusion of the intervention period.

Procedure

The experimental group received bimanual activity through participation in the task of sport stacking. Sport stacking is an activity which requires the participant to use both hands to assemble plastic cups in predetermined patterns using sequences that follow the rules sanctioned by the World Sport Stacking Association. Sport stacking materials were made available for this study from Speed Stacks®, Incorporated. A SportPack was supplied containing sports, DVD, practice and competition mats, minis, Super Stacks, and unit plan. The five day unit plan was used to provide content and skill or activity progression for the intervention; however, it was modified to con-

form to the intervention protocol. Specifically, there were two modifications. The first modification involved reconfiguring five approximately one-hour lessons of the Speed Stacks® Incorporated unit plan into 18 20-min. sessions. The second modification was the deletion of the relay races; given limited space, only the classroom was available for speed stacking activity.

The intervention protocol consisted of sport stacking instruction and practice for 20 min., three times per week, for a six-week period. The intervention was given during the school's snack time. The control group was engaged in snack time while the experimental group was sport stacking. The experimental group was given snack time at a later time in the school day. All intervention sessions occurred on a regularly predetermined schedule so that it was consistent for each class every week throughout the intervention period. Sport stacking activity was conducted in the experimental groups' classrooms with the classroom teachers present during every intervention session. The lead author performed all intervention sessions for the six-week period, to maintain consistency over time.

Each participant was given a set of 12 cups to use during every intervention session. Participants were encouraged not to practice between intervention sessions or to share their sport stacking skills with members of the control group. Participants had opportunities to practice all sport stacking activities taught during the interventions, however, actual sport stacking skillfulness was not assessed. The focus of the intervention was to provide opportunities for increased bimanual activity.

RESULTS

Decoding

A 2 (Group: experimental, control) \times 2 (Sex: boy, girl) analysis of covariance (SPSS) was used to compare the adjusted means of the posttest scores for the two participation groups, with pretest decoding scores as the covariate. There was no significant main effect of Group ($F_{1,41} = .03, p > .05; \eta_p^2 = .001$). In addition, there was no significant main effect of Sex ($F_{1,41} = .00, p > .05; \eta_p^2 = .000$). Finally, there was no significant participation Group by Sex interaction ($F_{1,41} = .68, p > .05; \eta_p^2 = .019$).

Comprehension

A 2 (Group: experimental, control) \times 2 (Sex: boy, girl) analysis of covariance was used to compare the adjusted means of the posttest scores for the two participation groups, with pretest comprehension scores as the covariate. The results indicated a significant main effect of Group ($F_{1,41} = 4.54, p < .05; \eta_p^2 = .112$). The experimental class performed significantly better on Comprehension. There was no significant main effect for Sex ($F_{1,41} = 1.93, p > .05; \eta_p^2 = .051$). In addition, there was no significant Group by Sex interaction ($F_{1,41} = 2.92, p > .05; \eta_p^2 = .075$).

Activity Questionnaire

The Activity Questionnaire return rate for the Grade 5 experimental group was 100% while the return rate for the control group was 50%. Therefore, the data were not used in interpretation of statistical results.

Classroom Teacher Interviews

The Classroom Teacher Interviews indicated that both experimental and control group teachers incorporated daily reading instruction into their teaching schedules for approximately 40 minutes. In addition, both teachers used the Macmillan/McGraw-Hill packaged reading program, appropriate for the Grade 5 students. Finally, both teachers utilized a balanced approach to reading instruction, whereby decoding and comprehension were emphasized.

DISCUSSION

The results indicated that bimanual activity did not have a significant effect on Grade 5 students' Decoding skills, regardless of sex. While it is plausible that these findings are simply the result of a co-occurrence (Hulme, 1988) and not indicative of a causal relationship, support for these results can be garnered from music-related research. Since musicians who began musical training prior to the age of seven were found to have larger anterior midsagittal corpus callosae (Schlaug, Jäncke, Huang, Staiger, & Steinmetz, 1995)—a measure related to the number of axons that cross the corpus callosum (Aboitiz, Ide, & Olivares, 2003) and capacity for communication from hemisphere-to-hemisphere—the finding of no difference in Grade 5 decoding abilities between the two groups might have been due to missing a critical period for development of the anterior midsagittal corpus callosum through bimanual activity, since all participants were beyond the age of seven. This is very tentative speculation, as measures did not assess changes in participants' brains.

Music-related research, using only a few minutes of musical training intervention on nonmusician participants, has resulted in positive effects on recruitment in areas of the motor cortex (Hund-Georgiadis & von Cramon, 1999). Given that the Hund-Georgiadis and von Cramon (1999) study incorporated only a few minutes of musical training to derive significant plastic benefits, it seems that a bimanual activity program of 20 min., three times per week, for six weeks might be more than adequate to affect significantly Grade 5 participants. However, because the assessment for reading ability used in this pilot study was not sufficient for assessing changes in the brain, the authors acknowledge the tentativeness of this finding.

The results indicated that bimanual activity may have had a positive significant effect on reading comprehension for Grade 5 participants, regardless of sex. These results, while to be taken with appropriate caution, are

consistent with findings by Roberts and Kraft (1989), who found that younger subjects, ages 6 to 8 years, who received an instructional emphasis on decoding, relied more on the left hemisphere when reading than older subjects, ages 10 to 12 years, who demonstrated bilateral activation when reading. These findings were explained by developmental differences and support the lateralization theory of the corpus callosum, as the left hemisphere was more engaged than the right while subjects were decoding (Clarke, McCann, & Zaidel, 1998; Byrnes, 2001). Older subjects' use of the right hemisphere in reading tasks has been cited as essential for comprehension (Banich & Nicholas, 1998).

The current findings should be considered with caution, as they are preliminary in nature, in efforts to seek empirical evidence for the current educational trend to support brain research by focusing on increased bilateral movement for enhancing academic achievement. The potential relationship of the capacity or activation of the corpus callosum with the findings of this pilot study is only speculation and should be taken with caution. Indeed, a serious flaw in the study is the classroom cohorts tested; it is plausible that the results are an extension of differences in the teachers' experience (30 yr. versus 1 yr.) more than anatomical changes due to cup stacking activity. A replication should be attempted.

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