Effects of Educational Kinesiology, Previous Performance, Gender, and Socioeconomic Status on Phonological Awareness Literacy Screening Scores of Kindergarten Students

Sandra Harmon Witcher

Dissertation submitted to the Faculty of the
Virginia Polytechnic Institute and State University
in partial fulfillment of the requirements for the degree of

Doctor of Education
in
Educational Leadership and Policy Studies

David J. Parks, Chairman
Christina M. Dawson
Travis Twiford
Patricia P. Kelly
Jeanne Edwards

March 27, 2001
Blacksburg, Virginia

Key Words: Kinesiology, Reading, Elementary

Effects of Educational Kinesiology, Previous Performance, Gender, and Socioeconomic Status on Phonological Awareness Literacy Screening Scores of Kindergarten Students

Sandra Harmon Witcher

(ABSTRACT)

Practitioners are obligated to identify cost-effective, worthwhile practices for improving student learning. With the current climate of pressure to quickly improve student performance on the Virginia Standards of Learning assessments, the use of Brain Gym® is an idea that has begun to pique the interest of teachers as an innovative instructional strategy. The value in conducting this research was to attempt to objectively analyze whether the use of this specific activity-based intervention in an educational setting affects children's skill acquisition.

Intact kindergarten classes from two relatively matched schools within the same southeastern Virginia school division were randomly assigned to the treatment and control groups. A total of 126 kindergarten students in eight classes were involved. All of the classes were administered the Phonological Awareness Literacy Screening test in October as part of the system-wide pre-assessment of kindergarten students. In addition to regular instruction, the treatment group then followed a prescribed set of six Brain Gym® exercises for 8-10 minutes twice each school day until the PALS posttest was given in late spring. The classroom teachers received in-service training from the researcher to enable them to lead the treatment group in the daily performance of the Brain Gym® exercises. The treatment began after the completion of PALS pre-testing. The control group received regular instruction and did not participate in any Brain Gym® exercises.

Following a t-test for differences in previous performance, a four-way analysis of variance was performed on the total PALS scores. Using the Statistical Package for the Social Sciences and a predetermined alpha level of .05, the four-way ANOVA yielded a significant main effect for previous performance and non-significant main effects for Brain Gym® participation, socioeconomic status, and gender. A significant interaction effect was found only among Brain Gym® participation, socioeconomic status, and gender. The data were examined another way using a three-way analysis of covariance. After adjusting for previous performance, no significant main effects or interaction effects were found across the variables.

DEDICATION

To my husband, Rick.

Thank you for the strong support of your love and faith in me!

ACKNOWLEDGEMENTS

Thanks to Dr. Dave Parks for agreeing to serve as my committee chairman and allowing me to learn the lessons of "the process" in my own time. I appreciate your unwavering guidance and support. Thanks to my other committee members, Dr. Tina Dawson, Dr. Pat Kelly, Dr. Travis Twiford, and Dr. Jeanne Edwards for their open-mindedness, words of encouragement, and editing suggestions. Special thanks go to Dr. Travis Twiford and Dr. Mary Yakimowski for helping me over my last few hurdles. Thanks to Beth Gallup for sharing her computer expertise and to Paulette Gardner for keeping the whole cohort straight!

Thanks to Dr. Milton Liverman for permission to conduct the study and for the insights and advice from one whose "been there." Thanks to Joyce Trump, Janice Holland, Jackie Marshall, and Dr. Lynn Cross for keeping a check on my progress. Thanks to Vivian Covington for introducing me to the Tech program when we were working "across the road" from each other. Thanks to Pat Montgomery for your mentorship and to Terry Napier for digging for data. Thanks to the kindergarten teachers for buying-in to the project and serving their roles well. Thanks to all my colleagues and friends for your patience, encouraging words, and desire to share in my celebration.

Most importantly, I owe a debt of gratitude to my family. To my husband Rick, there are not enough ways to say thank you for all you have done for me. You are the reason I was able to reach this milestone. Thanks to my Nana for roots, to my Roddy for wings, to Dawn and Heather for the unique friendship of sisterhood, and to Judith for taking care of us all. You have always been my "fan club." Thanks to Mamasita and Roger for sharing with me their son and keeping us in their prayers. Thanks to Miss Emily for all the joy you bring to our circle. Being able to celebrate with my family has made all of the sacrifices worthwhile. Whatever is good about me is because of your love!

LIST OF TABLES

LIST OF TABLES

LIST OF FIGURES

Figure Page

TABLE OF CONTENTS

CHAPTER I
THE PROBLEM AND RELATED LITERATURE REVIEW

Context

The traditional view of intelligence is that it is static, innate, and does not change much with age, training, or experience. There is a growing faction, however, that views intelligence as neither static nor singular. This school of thought is expressed by Gardner (1999 & 1993b) who proposed a Multiple Intelligences (MI) theory. He developed his theory after analyzing vast sources of information from such fields as neurology, biology, and psychology that, to his knowledge as a psychologist and neuropsychological researcher, had never been considered together. Particularly interesting were the increasing insights about the ways "normal" human abilities break down under conditions of different types of brain damage. Evidence that various abilities can be destroyed or spared in isolation from other abilities seems to indicate that the nervous system allows certain discrete kinds of intelligence.

Gardner (1999 & 1993b) explained that each of his eight theoretical intelligences is a biophysical potential that is manifested within particular disciplines or crafts practiced in a society. None of the eight intelligences identified by Gardner operates in isolation, and individuals exhibit each of them to varying degrees of strength (Gardner, 1999 & 1993b). They are briefly defined in Table 1.

Table 1

Eight Intelligences of Gardner's Multiple Intelligence Theory

Intelligence	Core components
Logical-mathematical	Sensitivity to patterns, orderliness, and systems; ability to handle long chains of reasoning
Linguistic	Sensitivity to the sounds, rhythms, and meanings of words; sensitivity to the different functions of language
Musical	Abilities to produce and appreciate rhythm, pitch, and timbre; appreciation of the forms of musical expressiveness
Spatial	Capacities to perceive the spatial world accurately, to perform transformations and recreations of visual experience
Bodily-kinesthetic	Abilities to control one's body movements and to handle objects skillfully
Interpersonal	Capacities to discern and respond appropriately to the moods, temperaments, motivations and desires of others
Intrapersonal	Access to one's own feelings, the ability to discriminate among them and draw upon them to guide behavior
Naturalist	Capacities to discern between species, chart their relations, and interact comfortably in the world of organisms

Note. Adapted from Intelligence reframed: Multiple intelligences for the 21st century by Howard Gardner, 1999, New York, NY: Basic Books. Copyright 1999 by Howard Gardner.

Gardner (1993b) stated that his MI theory is consistent with much empirical evidence, yet he acknowledged that it has not been subjected to strong experimental tests within psychology and has met with an overall lukewarm reception, at best, among fellow members of his discipline. Within the field of education, however, the basic tenets have been enthusiastically received, and applications of the theory are currently being examined in many projects such as Key Schools, Project Spectrum, and Arts PROPEL (Armstrong, 1994; Gardner, 1993b; Kornhaber, Krechevsky, & Gardner, 1990).

In the field of education, MI theory is primarily associated with encouraging the use of a variety of assessments that allow individuals to demonstrate their understanding in ways comfortable for them (i.e., not merely through the traditional paper and pencil tests that are typically measures of linguistic-logical intelligence). Such comfortable demonstrations do not preclude accountability standards (Gardner, 1993a). Examples of alternative assessments with which educators are now becoming more familiar include: (1) collecting portfolios of student work that show growth over time, (2) using rubric scoring systems for evaluating the quality of work, and (3) encouraging personal reflections by the students about their own work and progress.

Advocates stress that implementing alternative methods of assessment is an important step in the right direction, but that the effort must be extended to educational approaches which foster in-depth understanding—the kind of knowing that can be transferred and successfully applied to new problems in new contextual situations. Armstrong (1994) advocated linking all instructional objectives to Gardner's multiple intelligences for maximum learning in kindergarten through grade twelve. Hylton and Hartman (1996) found a similar trend toward matching medical students' learning needs to their environment through a problem-based format. DePauw (1998) articulated the importance of universities moving from an elitist teaching paradigm to a learning paradigm that encompasses an understanding of the mind-body connection and facilitates excellence in all. A broad perusal of literature across several disciplines is summarized in Appendix A, including both empirical evidence and opinions that support the pluralistic concept of intelligence captured within MI theory.

Any theory in such relative infancy offers myriad research opportunities. Suggestions that the mind is organized into relatively discrete realms of functioning not only lend support to Gardner's MI theory, but are also the basis of techniques developed by Dennison, P. E. and Dennison, G. E. (1985).

The Dennisons' views of learning through movement could be viewed as kindred with Gardner's bodily-kinesthetic intelligence. The process of facilitating learning through the use of movement is generally termed educational kinesthetics. Dennison, P. E. and Dennision, G. E. (1986), took educational kinesthetics a step further by incorporating principles of yoga and accupressure to comprise the trademarked Brain Gym® program. The Brain Gym® program encompasses 26 simple exercises designed to stimulate both brain hemispheres to work synchronistically so that optimal, or at least enhanced, learning and performance may be achieved. It is in the interest of achieving optimal performance that proponents of Brain Gym® claim their menu of educational kinesthetics may serve as an innovative, holistic approach to teaching, learning, and assessment.

History of Brain Gym®

According to Dennison (1981), Brain Gym® is an outgrowth of clinical work he conducted in 1969. With a background in reading and a special interest in learning difficulties, he began searching for ways to help his students progress. His search led him to the field of kinesiology from which he expanded and adapted previously established knowledge about the effects of children's developmental movements on their later cognition. The Dennisons' (1986) beliefs in developing Brain Gym® were that systematic use of specific body movements, in conjunction with deep breathing and plenty of water intake, can stimulate the human brain to function in a hemispherically integrated state for optimal learning potential regardless of age.

The methods of Brain Gym® are based in part on scientific findings about the right brain hemisphere controlling the left side of the body and the left brain hemisphere controlling the right side of the body (Geschwind & Levistky, 1968; Ross, et al., 1997). Admittedly oversimplifying the complexities of this organ, the developers' explain that

their purpose is not to teach human brain physiology, but to use functionally-oriented language to inform people how they may improve their lives (Denison & Dennison, 1985). Their use of the terms left-brain and right-brain refer to the dominant functions of the left and right hemispheres of the cerebral cortex improve their lives (Dennison & Dennison, 1985). Also called the analytic brain and the center of language, left-brain dominant functions include, but are not limited to: (1) sequencing and organizing information, (2) accessing short-term or working memory, and (3) generating and storing the ability to speak and understand verbal information. Also called the Gestalt brain and the center of creativity, right-brain dominant functions include, but are not limited to: (1) orientation in space and body awareness, (2) rhythm and tone, (3) artistic abilities, and (4) accessing long-term visual memories.

Dennison & Dennsion (1985) emphasized the benefits of Brain Gym® for hemispheric integration in the following summary:

> In order for the right and left brain to work in integrated fashion, the two brain hemispheres are interconnected by the corpus callosum, an intricate bundle of nerve fibers. In infancy, a complex system of switches is developed during the first few months of life. Ideally, as we first creep, and then crawl, we begin to synchronize and integrate information so that the two hemispheres can work together through life in harmony and coordination. One hemisphere can take over for the other and also operate on its own side to process a given task. To learn a new task easily, both sides of the brain need to be involved in the operation. (p. 8)

The Dennisons (1985) further explained, “When one side of the brain is in control, the other side either cooperates and coordinates its movements with the controlling hemisphere, or it may ‘switch off’ and block integration” (p. 8).

Dennison (1981) categorized Brain Gym® exercises as follows: (1) midline movements, (2) lengthening activities, (3) energy exercises, and (4) deepening attitudes. Examples of all, except lengthening activities, are included in this study. How to perform

the selected exercises and their specific purported academic benefits are described in more detail in the Methodology section.

In general, midline movements involve crossing the left-right vertical midline of the body and the left-right visual fields. Crossing the midline is essential for efficient coordination of fine and gross-motor activities and for coordinated eye movements (Dennison & Dennison, 1994). Midline movements used in this study include Cross Crawl, Lazy Eights, and Double Doodles.

Energy exercises theoretically reestablish neural connections between the body and brain essential for any human function. Derived from the acupuncture meridian theory, electrical circuits of the body act as energy conduits that can become blocked, overloaded, or switched off as a result of inactivity or stress (Dennsion, 1981). Brain Buttons and the Thinking Cap are two energy exercises used in this study (Dennison & Dennison, 1987).

Activities for deepening attitudes involve relaxation techniques similar to mental imagery and deep breathing. Cook's Hook-ups is the two-part exercise selected from this last Brain Gym® category. Performing this exercise is supposed to activate the brain for emotional centering and increased attention (Dennison & Dennison, 1989).

Paul and Gail Dennison founded in 1987 the Educational Kinesiology (Edu-K) Foundation, a non-profit public benefit corporation based in Ventura, California. The members of the foundation are committed to Dennison's proclaimed discoveries regarding the interdependence of physical development, language acquisition, and academic achievement. Brain Gym® is licensed through the Edu-K Foundation, an organization that also sponsors a variety of courses advertised for accessing more human physical and mental potential. Completion of a prescribed program of study leads to certification as an Edu-K Foundation kinesiologist. A sampling of such courses is in Table 2.

Many related publications are also available for purchase. Some offerings from the catalog Turning Point—Resources for Growing Minds (1996) published by Eric and

Diane Jensen are presented in Table 3. This particular issue is entitled “The Brain Store” with prices valid through December 31, 1996.

Table 2

Educational Kinesiology Foundation's Summer 1999 Course Offerings

Title	Hours	Tuition
Brain Gym® 101	24	$350.00
Brain Gym® 101S Brain Gym® for Special Education Providers	32	$350.00
Brain Gym® 240 Backing Up to Move Forward	24	$350.00

Note. If registered by June 11, 1999, with a $50.00 non-refundable deposit, the cost for each course was $300.00.

Table 3

Books Related to Educational Kinesiology and Brain-Based Learning Available in Turning Point Catalog

Author(s)	Title	Cost
Steve Allen & Martha Weston	The Laughing Classroom	$14.95
Dr. Thomas Armstrong	The Myth of the ADD Child	$23.95
Tony Buzan	Use Both Sides of Your Brain	$10.95
Laura Ellison	Seeing With Magic Glasses	$14.95
Dr. Carla Hannaford	Smart Moves	$15.95
Eric Jensen	Super Teaching	$24.95
Andrew Schwartz	Guided Imagery Groups	$24.95

Purpose of the Study

The value in conducting this research is to attempt to objectively analyze whether the use of Brain Gym® in an educational setting affects children's skill acquisition. The underlying tenet of Brain Gym® is that learning can be enhanced through simple, specific, movements that stimulate both hemispheres of the brain to work synchronistically. Positive results are reportedly immediate, demonstrable, and even more significant for students with learning difficulties. While the concept seems plausible, the existence of both monetary and opportunity costs cannot be ignored.

Practitioners are obligated to identify cost-effective, worthwhile practices for improving student learning. With the current climate of pressure to quickly improve student performance on the Virginia Standards of Learning assessments, the use of Brain Gym® is an idea that has begun to pique the interest of teachers as an innovative instructional strategy. Results of this study would be shared with teachers and administrators to guide decision-making regarding this classroom practice and staff development related to it.

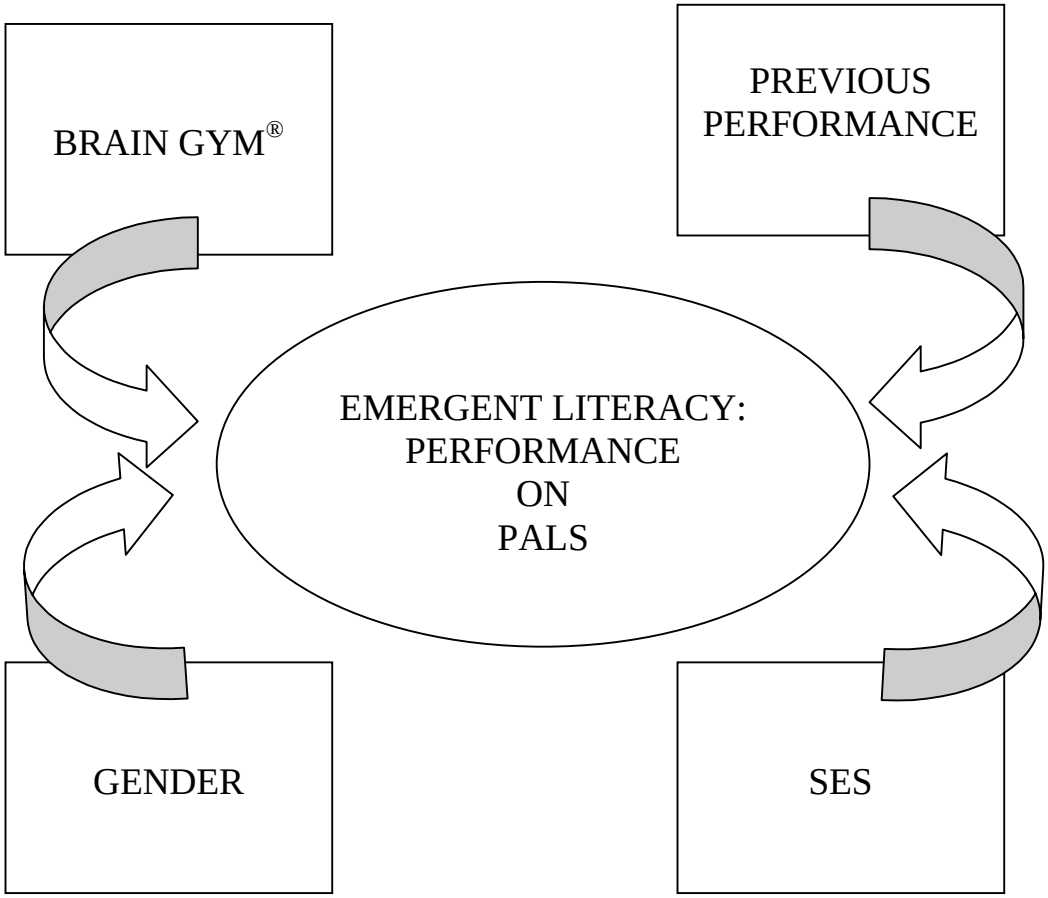

Figure 1. Model of effects of Brain Gym®, previous performance, gender, and socioeconomic status on Phonological Awareness Literacy Screening (PALS) scores.

A Model of the Effects of Brain Gym®, Previous Performance, Gender, and Socioeconomic Status on the Phonological Awareness Literacy Screening (PALS) Scores of Kindergarten Students

Two areas of research are pertinent to the theoretical framework (see Figure 1) of the current Brain Gym® study: (1) related Educational Kinesiology (Edu-K) research, and (2) phonological awareness research, especially as it corresponds to the effects of gender, socioeconomic status (SES), and previous performance on reading and language achievement in young children. The research findings from a review of literature support the theoretical framework for this study in that each of the outer boxes represents a variable that has been shown to have a direct effect on student literacy achievement.

The measure for student literacy achievement in this model, as indicated in the center oval, is performance on the Phonological Awareness Literacy Screening test. Based on the review of literature, the researcher expects to find the following main effects: (a) participation in Brain Gym® will significantly improve the posttest performance of students on the PALS test, (b) those students who have a higher score on the pretest will also score higher on the posttest, (c) females will score higher than males, and (d) students from the low socioeconomic-status group will score lower than those from the high socioeconomic-status group. The only expected interaction effect is that those students with low pretest scores who participate in Brain Gym® will have a greater increase in their posttest scores than those Brain Gym® participants who were high-scoring previous performers. All other interaction effects, however, will be tested.

Research Associated with the Relationship Between Participation in Brain Gym® and Student Performance

Only three published experimental studies related to Educational Kinesiology (Edu-K) were found. Khalsa conducted two in cooperation with other researchers and Cammisa conducted one. Two of the three experiments involved single treatments of Brain Gym® exercises (i.e., pretest, treatment, and posttest were conducted the same day). Two of the studies involved elementary-age, learning-disabled students as subjects, and one involved adults. Significant outcomes resulting from participation in Brain Gym® activities were reported for all three studies.

Khalsa, Morris, and Sifft (1988) examined the ability of 60 learning-disabled elementary school students to maintain static balance on a board during a modified stork-stand. Ranging in age from seven to eleven years, the students were matched according to age and gender and assigned equally to two Brain Gym® treatment groups and one control group. The first treatment group was called the integration-movement-only group. This group performed four Brain Gym® exercises for five minutes twice a day. The treatment continued five days a week for six weeks. The other treatment group in this experiment received an additional 10-minute precursor session termed laterality repatterning. Laterality repatterning is the performance by of arm and leg movements that are specifically coordinated with required eye movements. One example that illustrates laterality repatterning involved students looking up and to the right while raising their right arm and lifting their left leg. The control group received no intervention techniques.

Mimicking a stork's stand, students were required to stand on one foot with the other foot hooked around the back of their knee. Their hands were placed on their hips and they were timed during three 10-second trials in each of four consecutive conditions: (1) left foot, eyes open; (2) right foot, eyes open; (3) left foot, eyes closed; (4) right foot, eyes closed. "The means for the three trials in each condition were combined as the total balance score, with a total of 40 sec. possible" (Khalsa et al., p. 52).

A one-way analysis of variance was computed on gain scores between pretesting and posttesting. Differences in improved balance time by groups was significant ($F = 22.92$, $df = 1, 59$, $p = .0001$). The laterality-repatterned-plus-integration-movement group improved more ($M = 7.6$ sec., $SD = 4.9$, $N = 20$) than the integration-movement-only group ($M = 4.9$ sec., $SD = 2.4$, $N = 20$), and both treatment groups improved more than the control group ($M = .3$ sec., $SD = 2.5$, $N = 20$).

Significant results were found in another experiment by Sifft and Khalsa (1991) that again involved laterality-repatterned-plus-integration -movement and integration-movement-only treatment groups. In this case college students ranging in age from 19 to 40 years improved their response times to a four-choice visual stimulus task after only a single, 10-minute Brain Gym® treatment consisting of seven exercises ($F = 4.33$, $df = 2, 54$, $p \leq .01$). The pretest and posttest task required that a subject view a panel of lights on a Lafayette 4-choice visual reaction time apparatus. The subject had to push a button that corresponded with the light displayed in each of 30 trials, and reaction time was measured with a .001-sec. digital clock component of the machine. The differences between mean pretest scores and mean posttest scores were analyzed.

Using a 2 x 3 (gender x group) analysis of variance, Sifft and Khalsa (1991) reported a significant main effect for Brain Gym® participation groups ($F = 4.33$, $df = 2, 54$, $p \leq .01$). As indicated by faster reaction times, the laterality-repatterned-plus-integration-movement group performed better on average ($M = 419.1$ msec., $SD = 36.5$, $N = 20$) than did the integration-movement-only group ($M = 421.4$ msec., $SD = 40.9$, $N = 20$). Both experimental groups outperformed the control ($M = 437.1$ msec., $SD = 49.4$, $N = 20$). No significant differences were noted for gender ($F = 0.61$, $df = 1, 54$, $p > .05$) or the interaction effect ($F = 0.08$, $df = 2, 54$, $p > .05$).

In these two experiments, subjects ranged in age from seven to forty years. A set of five to seven Brain Gym® exercises was performed as the treatment in single-session or multiple-week formats. The significant findings in each case indicate that Brain Gym® activities may benefit participants' posttest performance on perceptual and motor tasks regardless of gender or duration of treatment.

Cammisa (1994) examined the effects of a year-long educational kinesiology program on both academic achievement and perceptual motor skills of children ranging in age from 7 to 17 years. Six females and 19 males attending a private school for students identified with specific learning disabilities were the subjects. All of the sampled students were white and from middle-class homes. They participated in a treatment described as "an Educational Kinesiology program provided by a certified Educational Kinesiology instructor for one school year" (Cammisa, 1994, p. 105).

In Cammisa's (1994) study, pretest and posttest scores from the Perceptual Motor Assessment for Children were used to measure the student's perceptual motor ability. Academic achievement was measured using scores on the Comprehensive Test of Basic Skills taken from school records. Achievement scores for the year prior to beginning the educational kinesiology program were used to estimate expected achievement because the study was retrospective. "With subjects serving as their own controls, it was assumed that improvement would be approximately the same each school year" (Cammisa, 1994, p. 105). Paired t-tests with two-tailed probability were used to analyze the data.

Cammisa (1994) reported significant improvement from 92.5 ± 10.5 to 100.9 ± 9.1 in perceptual motor skills following the educational kinesiology program ($t = 5.3$, $p < .0001$). In the comparison of subjects' grade equivalent scores for language, arithmetic, and reading on the Comprehensive Test of Basic Skills for the year prior to the educational kinesiology program and for the testing after the program, no significant differences in gains were found. Cammisa (1994) noted that limitations of the study included lack of a true control group and use of the Comprehensive Test of Basic Skills with a population different than that on which it was normed. Cammisa (1994) concluded that the treatment may have been effective in improving the perceptual motor skills in the sample of learning disabled children and "unlike other reports (Educational Kinesiology Foundation, 1989) this study did not yield significant academic changes following treatment" (p. 106).

In an unpublished dissertation, Travis (1989) reported insignificant results from her quasi-experimental examination of the effects of educational kinesthetics on performance. A total of 75 adult students enrolled in a federally funded vocational employment training program were the subjects in the study. Subjects were advised of the general nature of the study and the time involved and invited to volunteer. Willing participants were randomly assigned to experimental and control groups. Ranging in age from 18 to 65 years, the students were pre-tested and post-tested for visual efficiency, typewriting speed, and typewriting accuracy.

The treatment group performed 10 minutes of educational kinesthetics during the morning and afternoon sessions of class for four weeks. They were also asked to perform the same exercises at home before retiring for no more than 10 minutes daily. The control group was given no instruction in how to perform the exercises, and the students were not allowed to type during the time that the treatment group was performing their educational kinesthetics. Two separate two-way ANOVAs were performed on the differences in pretest and posttest scores for both typewriting speed and typewriting accuracy. Travis (1989) found no differences on typewriting speed by Brain Gym® participation (treatment, control) and visual efficiency group (efficient, non-efficient), and no differences were found for either group on typewriting accuracy.

The Educational Kinesiology Foundation in Ventura, California publishes articles three times a year describing the benefits people have experienced as a result of using educational kinesthetics. Each issue of the Brain Gym® Journal is comprised of international success stories describing programs that are as varied as the authors' backgrounds. Notable similarities include the facts that the articles were anecdotal in format, most of the authors were certified through the Edu-K Foundation as consultants, and Brain Gym® techniques were usually used in combination with some other type of learning intervention strategy. The Brain Gym® Journal articles most relevant to this study dealt with practices implemented in school settings. The following two summaries of articles from the April 1999 issue may be viewed as typical for all three issues of the same year.

Paul Ruta (1999), a retired classroom teacher who holds a master's in education and has 20 years of experience at all grade levels, reported in the Brain Gym® Journal that he has recorded the positive results of using a combination of Dennison's Brain Gym® and MacLean's Accelerative Learning with over 100 people of all ages and challenges. He stated that during the many workshops and inservices he has presented in Canada, more than 1,500 parents, teachers, and counselors have inquired about how to use educational kinesthetic techniques to counteract the challenges associated with learning disabilities.

Susan Diamond (1999) holds a Ph.D. in educational psychology and has a private educational consulting practice that includes Electroencephalogram neurotherapy, audio-visual stimulation, and sensorimotor integration activities. She described in the Brain Gym® Journal several projects she conducted in British Columbia public schools. One involved training the 27 teachers and support staff of an elementary school serving 452 students from a middle-to-lower income neighborhood. School personnel then developed a study (unpublished) involving 24 students from grades one through four.

These students had been designated to attend the school's Learning Assistance Program because they scored two standard deviations below the norm on the Canadian Achievement Test or scored two grade levels behind in reading, spelling, language, or math on an unnamed test. An additional eligibility requirement for participation in the Learning Assistance Program was an intelligence quotient score above 90 on the Weschler Intelligence Scale for Children. The students were reportedly randomly divided into two equal groups.

The experimental group received a multi-method intervention including Brain Gym®, and the control group proceeded with the regular, yet reputably successful, Learning Assistance Program. The author stated that it was "apparent" (Diamond, 1999, p. 6) after six weeks that the experimental group was advancing faster than the control group. She also said that noticeable improvements in spelling and math-fact skills were observed in nine out of twelve students in the experimental group.

Research Associated with Phonological Awareness

"Maximizing student performance while considering individual differences" (Abland & Lipshultz, 1998) could be considered the universal mission of educators and educational researchers. One of the many individual differences addressed by both groups is gender-specific cognitive processing and achievement apparent not only in adulthood, but also evident in the form of stereotypical thinking demonstrated by elementary-school-age children (Trepanier-Street, Romatowski, & McNair 1990). Another individual difference among students is the sociocultural aspects of their lives. This factor affects how they actively construct knowledge for different purposes in their literacy development (Quintero & Huerta-Macias, 1995) and how differences, such as ethnicity, that are apparent for metacognition and academic measures, disappear when socioeconomic status is treated as the independent variable (Wang, 1993).

Parents, teachers, business leaders, and administrators recognize a need for reform in the area of student achievement. Between 15% and 30% of all students have reading problems, and most of these students come from low-income families (O'Sullivan, 1992). Between 60% and 90% of elementary school children referred for remedial reading instruction are male (Blom, 1971). There is a reason for concern regarding reading achievement in the nation's public schools. Brown (1991) wrote, "Empirical studies suggest that both gender and socioeconomic status are strongly correlated with student achievement" (p. 343).

All of these individual differences are then compounded by the fact that researchers disagree on how oral and written language develops in children (Campbell, 1990; Snow, 1991). One school of thought supports the argument that written language has few if any of the naturally acquired and universal features of oral language and requires specific and strategic direct instruction (Campbell, 1990). Opposing views uphold the notion people have a natural inclination to write which requires only immersion in a print-rich environment with holistic language approaches (Snow, 1991; Quintero & Huerta-Macias, 1995).

Collectively the researchers suggest that students from lower socioeconomic status families tend to have lower achievement levels measured by standardized tests, that boys do better in mathematics, and that girls do better in reading (Brown, 1991). Examining the effects of both gender and socioeconomic status with the use of any instructional strategy appears worthwhile to ameliorate the consequences of these individual and inherited differences for students.

Research Related to the Effects of Previous Performance on Student Achievement

Lezotte and Passalacqua (1978) conducted a study about the effects of individual school buildings on student achievement. The sample consisted of 2500 students selected randomly from each classroom of 20 urban elementary schools. Total reading and total mathematics scores from the 1972 Iowa Test of Basic Skills (ITBS) were used as the measure of prior achievement. Reading and mathematics totals from the 1973 ITBS were used as the measures of current achievement.

A multiple linear regression was performed using prior achievement and school building attended as independent variables (Lezotte & Passalacqua, 1978). While the effect of building attended was their primary interest, the reported finding most relevant to this study was that prior academic performance was a significant predictor of future performance. They reported that the 1972 reading and mathematics achievement scores accounted for 25 per cent of the variance in reading achievement and 23 per cent of mathematics achievement on the 1973 assessments.

Byrne and Fielding-Barnsley (1993) conducted a follow-up study evaluating a program to teach young children about phonemic structure. In the original 1991 study conducted by the same researchers, 64 preschoolers were trained with the program in groups of four to six for approximately one-half hour over 12 weeks. They reportedly gained in phonemic awareness and knowledge of the alphabetic code as compared with a control group. The children were retested at the end of kindergarten on phonemic awareness, word identification, decoding, and spelling.

Children who entered school with advanced levels of phonemic awareness, regardless of whether it was learned as a result of the researcher's specific program or not, scored significantly higher on each of the measures.

Research Related to the Effects of Gender on Student Achievement

According to Park, Bauer and Sullivan (1998), "there have been a plethora of factors identified as contributing to the existence of gender gaps in academic performance" (p. 140). One common research finding is that elementary-school boys read more poorly than do girls (Dwyer, 1973; Holbrook, 1988; Stein & Smithells, 1969). According to Blom (1971) between 60% and 90% of elementary school children referred for remedial reading instruction are male.

Thorkildsen and Nicholls (1998) reported that boys and girls achieve differently because they view success in school differently, including their motivational orientations, beliefs about the causes of success, and perceptions about teachers' expectations. Additional variables such as age, grade-level placement, curriculum, and instructional strategies in schools reportedly affect the performance of girls and boys differently in language arts and other subjects (Cooper, Lindsay, Nye, & Greathouse, 1998; Mackey, Johnson, & Wood, 1995).

Dwyer (1973) and Williams (1989) agreed that reasons for observed gender differences could be categorized. Maturational level encompasses the belief that girls achieve better in reading because they are more developmentally ready to learn to read. Reading materials comprise the second category because the content of reading materials is generally considered more appealing to girls than to boys. Finally, cultural explanations encompass the notion that boys' depress their achievement because success in school conflicts with their perceptions about masculinity.

Gender differences related to maturational level.

Because girls mature at a faster rate than boys, it is easier for girls to adapt to the physical limitations imposed on students by the educational process (Dwyer, 1973). Pauley found (as cited in Dwyer, 1973) that first grade girls achieved significantly higher scores on reading assessments than did boys, even though the boys in the study were older than the girls. Because the boys were older, it would be reasonable to assume that they would outperform the girls. Pauley's findings indicate, however, that if chronological age is considered a reliable index of maturation, maturation alone cannot account for better achievement among girls than boys (as cited in Dwyer, 1973).

Accepting a singular maturational explanation for gender differences may not be sufficient. Although physical maturational differences are in favor of girls, girls as a group do not have higher achievement than boys in all subject areas (Dwyer, 1973; Holbrook, 1988; Sheridan & Fitzdale, 1981; Stein & Smithells, 1969). Gender differences in reading, therefore, may be accounted for by alternative or additional explanations.

Gender differences related to reading materials.

The content of reading material has generally appealed more to girls than to boys (Ascher & Markell, 1974; Dwyer, 1973; Holbrook, 1988). Ascher and Markell reported that boys scored as well as girls when using materials the boys' rated as "highly interesting," but scored below girls on materials of low interest. These results suggest that reading is acceptable to boys when the content is of interest to them and is perceived as masculine. Steiner, Steinen, and Newman (1981) wanted to determine when boys began to view reading as an inappropriate activity. They found no significant difference in girls' and boys' reading achievement over a sample of four grades from two parochial schools. There was also no difference in the children's perceptions about reading, as it was deemed an appropriate activity for both boys and girls. These results suggest that gaps between boys' and girls' reading achievement may be substantially reduced if boys are taught and tested using material they deem interesting.

Gender differences related to culture.

Gates (1961) suggested cultural explanations for gender differences in reading achievement, including a "feminized" school environment that may better meet the needs of girls than of boys. Stein and Smithells (1969) found that second-, sixth-, and twelfth-grade boys and girls rated reading as a feminine activity. Reading was rated more feminine than math, spatial and mechanical skills, and athletics, but less feminine than social and artistic activities. Steiner et al. (1981) wrote, "educators in favor of the societal-cultural theories believe that in the United States young boys perceive reading as a feminine activity" (p. 8).

Dwyer (1974) reported data that support the findings of Gates (1961), Stein and Smithells (1969), and Asher and Markell (1974). He found that children's sex-role perceptions about reading accounted for a significant amount of the variance in their reading achievement scores. This finding was reported for grades two through twelve. The strength of society's seemingly unwritten rules against males participating in any part of the stereotypical feminine role may alone have the effect of decreasing boys' motivation to excel in reading.

Research Related to the Effects of Socioeconomic Status on Student Achievement

Lanham (1999) examined the relationships between student achievement and a number of variables relating to building and classroom conditions in Virginia elementary schools. Using a systematic random sampling strategy, he selected three hundred schools out of all elementary schools with grades three and five in the Commonwealth. Demographics and classroom-building condition data were collected using a survey instrument. Student achievement was the dependent variable using scaled scores from the spring 1998 Standards of Learning Assessments for English (grades three and five) and mathematics (grades three and five). As scaled scores were not available for the fifth-grade technology assessment, the percentage passing this assessment was used as a measure of achievement.

Lanham (1999) conducted a step-wise multiple regression analysis using each of the Standards of Learning assessments as the criterion variable. He found that none of the building condition variables entered the equation first in any of the five multiple regression analyses. Instead, in all five cases, the percentage of students participating in the free and reduced-price lunch program was the first variable entering the equation and accounted for the greatest percentage of variance in test scores. In reviewing the English assessment scores, free and reduced-price lunch percentages accounted for 48 per cent of the variance at third grade and 52 per cent of the variance at fifth grade. For each additional percentage free and reduced-price lunch participation, the English assessment score declined by .82 points. A similar finding was reported in the technology assessment analysis, with free and reduced-price lunch percentage accounting for 41 per cent of the variance in technology test scores. For each additional percentage of free and reduced-lunch participation, the percentage passing the technology assessment declined by .47 points (Lanham, 1999).

When reviewing the mathematics assessment scores, Lanham (1999) found that the free and reduced-price lunch percentage accounted for only 26 per cent of the variance in third grade mathematics scores, and only 16 per cent of the variance in fifth grade mathematics scores. For each additional percentage of free and reduced-price lunch participation third grade mathematics scores declined by 1.17 points and fifth grade mathematics scores by .63 points. He concluded that student achievement in mathematics, as measured by these tests, appears to be less affected by socioeconomic factors than student achievement in English or technology. The results parallel those found by Cash (1993), Hines (1996), and Earthman, Cash, and Van Berkum (1996) in their studies of secondary schools (as cited in Lanham, 1999). Lanham also reported that similar results were found in the GAO study of Virginia schools (United States General Accounting Office, 1995) and the meta-analysis conducted by McGuffey in 1982 (as cited in Lanham, 1999).

Brown (1991) postulated that the strong correlation established in previous empirical studies between socioeconomic status and student achievement as measured by standardized tests might be the result of differences in learning efficiency on one hand or the result of differences in the allocation of instructional resources on the other. He found that socioeconomic status did not have a statistically significant effect on learning efficiency, in most cases, as measured by the Beginning Teacher Evaluation Study "which includes detailed observations on learning time in mathematics and reading in 21 fifth- and 25 second-grade California classrooms" (Brown, 1991, p. 346). Brown reported that there did seem to be some relationship between the effects of socioeconomic status on starting scores (students were tested three times during the school year), for both grades in both subjects. He stated the simple correlation of .72 indicated that the lower the socioeconomic status the lower the starting score on reading and mathematics testing. Brown (1991) also found that only for the fifth grade students was socioeconomic status an explanation for a significant portion of the variance in reading scores ($\underline{F} = 8.19$, $\underline{df} = 1, 226$, $\underline{p} \leq .01$). He reported his examination of the individual socioeconomic status coefficients for the fifth grade students showed the difference to be due to the much higher performance of the highest socioeconomic-status group compared to the other three socioeconomic-status groups (Brown, 1991).

O'Sullivan (1992) investigated the effects of gender and grade-level in school on 552 low-income students' reading proficiency. Interviews were conducted to determine students' beliefs about their reading, parents' beliefs about their children's reading, and teachers' beliefs about their students' reading. O'Sullivan's focus was to determine causes of reading proficiency for the students in a Canadian province in which the incidence of low-income families was considerably higher than the national average and the students routinely performed below the average on nationally standardized reading tests.

O'Sullivan (1992) reported that at third grade, females (M = 44.5, SD = 9.4, N = 81) had significantly higher scores than males (M = 39. 6, SD = 9.6, N = 99) on the Gates-MacGinitie Reading Comprehension Test. Similar findings were reported for sixth grade females (M = 45.7 SD = 9.8 N = 109) and males (M = 42.8, SD = 9.4, N = 100) as well as for ninth grade females (M = 44.2, SD = 9.4, N = 94) and males (M = 40.6, SD = 8.7, N = 69). Based upon responses to the interview questions, the researcher concluded the females at all three grade levels may have outperformed the males on the testing because "female students and their parents and teachers had much more positive beliefs about reading" (O'Sullivan, 1992, p. 19).

Findings from the research reviewed suggest that the independent variables in the theoretical framework for this study will likely have a direct impact on the dependent variable. Collective assumptions include, (1) students from a lower socioeconomic-status group tend to have lower achievement levels than students from a high socioeconomic-status group as measured by standardized tests, (2) females typically perform better than males on reading assessments, (3) students that have performed well on past measures of achievement continue to perform well on subsequent measures of achievement, and (4) that educational kinesiology may have some benefits as a technique for optimizing students' performance. Examining the effects of gender, socioeconomic status, and previous performance with the use of any instructional strategy is worthwhile as educators continue attempts to ameliorate the consequences of these individual differences for students.

Research Questions

Fifteen questions were generated from the four independent variables and one dependent variable depicted in the theoretical framework. To explore each of these questions, a 2x2x2x2 analysis of variance (ANOVA) was performed to test each null hypothesis with Brain Gym® (treatment, control), previous performance on PALS pretest (high, low), socioeconomic status (high, low), and gender (male, female) as independent variables, and PALS posttest scores as the dependent variable. Following a t-test for differences in previous performance on the PALS test, a three-way analysis of covariance

(ANCOVA) also was performed to answer questions 1, 3, 4, 6, 7, 10, and 13. Main effects and interaction effects were investigated in both analyses.

1. What is the difference in emergent literacy, as measured by the PALS test, between those students who participated in Brain Gym® exercises and those who did not?

2. What is the difference in emergent literacy, as measured by the PALS test, between those students who had low previous performance scores and those who had high previous performance scores?

3. What is the difference in emergent literacy, as measured by the PALS test, between students from low versus medium-to-high socioeconomic status families?

4. What is the difference in emergent literacy between males and females as measured by the PALS test?

5. What is the interaction effect of participation in Brain Gym® and previous performance on emergent literacy performance as measured by the PALS test?

6. What is the interaction effect of participation in Brain Gym® and socioeconomic status on emergent literacy performance as measured by the PALS test?

7. What is the interaction effect of participation in Brain Gym® and gender on emergent literacy performance as measured by the PALS test?

8. What is the interaction effect of previous performance and socioeconomic status on emergent literacy performance as measured by the PALS test?

9. What is the interaction effect of previous performance and gender on emergent literacy performance as measured by the PALS test?

10. What is the interaction effect of socioeconomic status and gender on emergent literacy performance as measured by the PALS test?

11. What is the interaction effect of participation in Brain Gym®, previous performance, and socioeconomic status on emergent literacy performance as measured by the PALS test?

12. What is the interaction effect of participation in Brain Gym®, previous performance, and gender on emergent literacy performance as measured by the PALS test?

13. What is the interaction effect of participation in Brain Gym®, socioeconomic status, and gender on emergent literacy performance as measured by the PALS test?

14. What is the interaction effect of previous performance, socioeconomic status, and gender on emergent literacy performance as measured by the PALS test?

15. What is the interaction effect of participation in Brain Gym®, previous performance, gender, and socioeconomic status on emergent literacy performance as measured by the PALS test?

Definition of Terms

Emergent literacy is defined as Kindergarten students' ability to identify letters, sound-symbol relationships, and basic sight words. In this study, emergent literacy was measured by the students' total score on the Phonological Awareness Literacy Screening (PALS) instrument (Invernizzi, Meier, Swank, & Juel, 1998).

Participation in Brain Gym® is defined as performance of the prescribed set of educational kinesthetic exercises twice a day during one school year. In this study it was measured by teacher observation of student participation in six given exercises each week until the PALS posttest was administered.

Previous performance is defined as the students' initial emergent literacy ability and was measured in this study by pretest performance on the PALS test. Scores were divided into low-scoring and high-scoring groups. Students with a total pretest score at or less than 28 were identified as the low group in previous performance. Those scoring above 28 were included in the high group of previous performance.

Gender is whether the student is male or female.

Socioeconomic status is defined as membership in a low or medium-to-high income family. In this study, students' eligibility for free or reduced-price school meals according to school records was the measure to demarcate the low socioeconomic-status group from the medium-to-high group (hereafter referred to as the high socioeconomic-status group).

CHAPTER II
METHODOLOGY

The purpose of this section is to describe how the study was conducted. The characteristics of the populations in the study are detailed as well as the characteristics of the measurement tool with respect to its construction, content, validity, reliability, and scoring procedures. Steps for administering the instrument are outlined. Finally, the quantitative design and statistical procedures employed for analyzing the data are discussed.

Populations and Samples

Two schools with a combined total of eight kindergarten classes are described here. Basic information obtained from school records about students, teachers and special programs are shared. The descriptive data provided are intended to give a comparative overview of the populations and samples.

Description of the Populations

Two public elementary schools in the same Southeastern Virginia school division were used in this study. This primarily rural system had 16 schools serving approximately 11,500 children in grades pre-kindergarten through twelve in the 1999-2000 school year. While the school designated as School A had 190 more pupils than School B, it was similar in ethnic composition, gender ratios, percentage of free or reduced-price-lunch recipients, percentage of Title I eligible students, and percentage of students receiving special education services. These schools were selected by the researcher for this study because of the similarity in student composition and the willingness of the principals to allow kindergarten classes to participate. Comparative descriptive data from each school's records as of December 1, 1999, are in Table 4.

Table 4

Number and Percentages of Students in the Populations by School, Gender, Ethnicity, and Special Status

School	Total	Gender		Ethnicity			Special Status		
		Male	Female	Black	White	Other	Title I	Special Educ.	Free or reduced-price lunch
A	547	290 (53)	257 (47)	443 (81)	99 (18)	5 (1)	138 (25)	84 (15)	376 (69)
B	357	199 (56)	158 (44)	201 (56)	147 (41)	9 (3)	76 (21)	37 (10)	226 (63)

Note. Percentages are in parentheses.

Description of the Samples

There were a total of eight kindergarten classes in the two schools. Classes were divided into experimental and control groups by random drawing of class names. In a given school, the first class name drawn was assigned to the experimental group and the next to the control group. This pattern was repeated until all classes in both schools were placed. A coin toss of heads determined that School A was to be the first school from which to draw class names (heads = School A, tails = School B).

A letter was sent home to the parents of the children assigned to the experimental group explaining the study and offering an opt-out clause. Two parental requests for opting their children out of the study were received by the same teacher at School B. After a follow-up phone call was made by the teacher to verbally explain the study, the opt-out requests were withdrawn by the parents and both students participated in the study. Any students who withdrew from or entered any of the kindergarten classes after the treatment began were not included in the groups to be analyzed. The classes were similar in size and demographic composition (see Table 5).

Table 5

Number of Students in the Samples by School, Gender, Ethnicity, and Special Status

Class no.	Total students	Gender		Ethnicity			Special status		
		Male	Female	Black	White	Other	Title I	Special educ.	Free or reduced-price lunch
Treatment									
School A									
1	14	7	7	11	3	0	2	0	8
3	16	6	10	13	3	0	1	0	12
5	15	8	7	14	1	0	1	3	11
School B									
6	18	10	8	12	5	1	0	2	12
8	17	8	9	8	9	0	0	3	8
Total	80	39	41	58	21	1	4	8	51
%	64	31	33	46	17	1	3	6	40
Control									
School A									
2	16	9	7	16	0	0	4	1	11
4	15	10	5	12	3	0	2	0	8
School B									
7	15	10	5	10	5	0	0	2	11
Total	46	29	17	38	8	0	6	3	30
%	36	23	13	30	6	0	4	2	24

All eight of the kindergarten teachers were female. Classes in School B each had a full-time instructional assistant, while those in School A had an assistant on a part-time basis. The average age of the teachers in School A was 29 years with an average of 5 years teaching experience at the kindergarten level. In School B the average age of the teachers was 50 years with an average of 19 years of teaching experience at the kindergarten level. A different picture emerges when looking at these data from the perspective of treatment versus control. The average age of teachers for both treatment and control was 37 years while the average number of years teaching experience at the kindergarten level was 13 and 5 respectively.

Two of the eight teachers had earned a master's degree in education. Two were enrolled in programs leading to a master's degree in reading and stated that they had completed half of their program requirements as of December 1999. The teacher of Class 1 participated with the researcher in completing a 24-hour Brain Gym® course in August 1999. The teacher of Class 7 remembered reading about Brain Gym®, but all others stated that they had no prior knowledge of such a program. Descriptive data on teachers are in Table 6.

Table 6

Description of Kindergarten Teachers

Class number	Age	Ethnicity	Years teaching			Degree(s)	College or university
			Total	K	Division		
				Treatment			
School A							
1	31	W	9	7	7	BS	James Madison Univ.
3	34	W	5	4	3	BS	Oakland Univ.
						MS	Old Dominion Univ.
5	28	B	6	6	6	BS	Virginia State Univ.
School B							
6	45	W	24	24	24	BS	Old Dominion Univ.
8	46	W	24	24	24	BS	Longwood College
						MS	Old Dominion Univ.
Mean	37		14	13	13		
				Control			
School A							
2	23	W	1	1	1	BS	East Carolina Univ.
4	29	W	6	6	6	BS	Longwood College
School B							
7	60	W	12	8	12	BS	Longwood College
Mean	37		6	5	6		

Treatment

The treatment group participated in the same series of Brain Gym® activities twice a day during one school year. The series was performed in the same order for a duration of eight to ten minutes. The first set was performed in the morning between 9:00 a.m. and 10:00 a.m. The second set was performed in the afternoon between 12:00 noon and 1:00 p.m. An hour-long window was provided to allow teachers some flexibility for dealing with the interruptions and adjustments that inevitably affect any school's regular schedule.

Teachers initially provided a general explanation to the students that the purpose of the exercises was to warm up their brains and get them ready for learning. The teachers also demonstrated how to perform the exercises while giving verbal directions. Hand-drawn posters were displayed in the classroom as additional visual guides for students. After the second week of treatment, verbal explanations of how to perform the exercises were only given to individual students as needed. Teachers led the exercises by calling the name of each exercise and performing it along with the students. The posters depicting children performing each exercise remained on display. The sequential set of Brain Gym® exercises performed by the treatment group are in Table 7.

Table 7

Series of Brain Gym® Exercises Performed by the Treatment Group

Name	Description of the exercise
Brain Buttons	Using thumb and forefinger of one hand, vigorously massage soft spots beneath clavicle for about one minute. Hold other hand flat against navel.
Cross Crawl	Touch hand or elbow to opposite knee while doing a slow, marching movement. Continue movement for about 20 repetitions.
Cook's Hook-ups	Part 1: Cross ankles. Extend arms, cross wrists, and join hands. Then curl hands down and back up to chest. Sit or stand in this position while breathing slowly and deeply for one minute. Part 2: Uncross hands and feet. Sit or stand with feet side by side and fingertips together at waist level. Continue breathing slowly and deeply in this position for an additional minute.
Lazy 8s	Face a wall and trace a figure of an eight (i.e., in the position of the infinity symbol) with outstretched left hand three times. Repeat with right hand. Repeat with both hands clasped.
Double Doodles	Draw in all directions using both hands at same time. Drawings can be done on horizontal surface (paper on desk) or vertical surface (chalkboard) for one minute.
Thinking Cap	Gently unroll outer edges of left ear from top to bottom three times. Repeat with right ear.

Note. Adapted from Brain Gym®: Teacher's edition revised by P. Dennison and G. Dennison, 1994, Ventura, CA: Edu-Kinesthetics, Inc. Copyright 1994 by Paul E. Dennison and Gail E. Dennison.

The exercises were sequenced to provide consistency for the treatment groups. The selection of exercises from the entire Brain Gym® learning menu, however, was a deliberate attempt to match the purported academic benefits of specific exercises with the kinds of academic tasks the children would be expected to perform on the PALS test. For example, performing Double Doodles is supposed to help integrate the visual fields for spatial awareness and visual discrimination, such that one could experience an improved ability to recognize letters and numbers. The academic purpose of Hook-ups is to promote positive attitudes, self-control, and increased attention. The remaining four exercises relate to visual and auditory focusing for improved tracking, symbol recognition, listening, comprehension, and spelling.

Students were encouraged by their teachers to participate fully in the entire sequence of six exercises, but no punitive action was taken against any student who did not participate. The teachers were originally instructed to record observations regarding individual student participation on a daily tally sheet (see Appendix B). This proved to be unnecessarily burdensome to teachers. The students participated in the Brain Gym® exercises just as they would for any whole-class activity and maintaining the tally sheets was omitted from the procedural requirements. Treatment was executed consistently by the teachers as observed by the researcher. On the few occasions when a substitute teacher had to be employed, the instructional assistant normally assigned to that class ensured that the exercises were performed.

Instrument

The instrument used to measure the dependent variable (emergent reading) was the Phonological Awareness Literacy Screening (PALS) test. PALS is the product of a grant-supported project based upon previous literacy assessment procedures and early reading intervention programs. It is a derivative of the Book Buddies assessment procedures used in Guidelines for Volunteer Tutors by Johnston, Invernizzi, and Juel (as cited in Invernizzi, Meier, Swank, Juel, The Virginia State Department of Education, & University of Virginia Curry School of Education, 1998).

The basic evolution of construction and content are outlined, followed by evidence supporting the reliability and validity of the test. Scoring procedures are detailed, including range of possible scores and task benchmarks.

Construction and Content

According to the test developers, PALS is a measure of young children's ability to demonstrate fundamental components of the learning-to-read process (Invernizzi, Meier, Swank, & Juel, 1998). These fundamental PALS components correlate with certain objectives from Standards of Learning for Virginia Public Schools, Kindergarten through Grade Three (1995), as identified in Table 8. According to Adams (1990) the key to literacy is the ability to accurately and rapidly identify upper- and lowercase letters combined with awareness of small units of sound (phonemes) within spoken words. The PALS test was designed to assess both of these areas plus a child's concept-of-word—the ability to match speech to print.

The ability to recognize upper- and lowercase letters is measured by the alphabet knowledge task. Students are shown a sheet of all lowercase letters of the alphabet arranged randomly in a five-column by five-row format. Students are asked to point to each letter of the alphabet and say the name of the letter to which they are pointing. The number of correct responses is recorded.

The PALS instrument measures a child's phonological awareness with several tasks. The letter-sound knowledge section is similar in format to the alphabet knowledge task. In this subtest, however, the letters are all capitalized and the child is asked to tell the sound the letter makes rather than to name the letter.

Table 8

Relationship of Phonological Awareness Literacy Screening (PALS) Components to Virginia Standards of Learning (SOL) Kindergarten Objectives

PALS component	SOL objectives	
Phonological awareness of rhyme	K.4	Identify orally words which rhyme. Sort words orally according to shared beginning, ending, or medial sounds.
	K.7	Recognize rhyming words.
Alphabet knowledge	K.5	Hold print materials in the correct position. Follow words from left to right and top to bottom on a printed page. Match voice with print, associating oral phonemes, syllables, words, and phrases with their written forms.
	K.9	Identify both uppercase and lowercase letters of the alphabet.

Another phonological awareness task is group rhyme awareness. Students are placed in small groups of five or less. The group is instructed to imitate the teacher as the teacher points to a picture and says the name of the picture. The demonstration is repeated for each of the four pictures. The student is then directed to circle the picture having the name that rhymes with the first picture named. Several items are used for guided practice prior to beginning the first actual screening item. The teacher prepares the students for each item with step-by-step instructions that may be repeated as necessary. The group beginning sound awareness sub-test is conducted in the same way, except that the focus is on the beginning sound of each picture's name. Any student who scores below the benchmark range on either of these two group tests is given an individual test on a different day, and the individual score is used to determine the summed score for that child.

The final sub-test of phonological awareness is spelling, during which a child is expected to use knowledge of letter sounds to attempt to spell words in writing. Even if the letter placement is out of order, phonetically correct spellings are scored higher than those spellings with just correct beginning and ending sounds.

The remaining PALS tasks are word recognition in isolation and concept of word. Only the latter is required of kindergarten students. The concept of word section entails recitation of a nursery rhyme while pointing to corresponding pictures. The four-line rhyme is repeated in this manner until the child can say it alone. The flip-side of the rhyme sheet is then used to model fingerpoint reading of the rhyme, which simply means pointing to each word as it is read. The child is then asked to fingerpoint read one line at a time immediately after the teacher has done so. One point is earned for each sentence in which the student correctly points to all words. Finally, the student is asked to identify the underlined word as the teacher points to it. There are two underlined words in each of the four sentences worth a point apiece. Scoring for this task is the total of points awarded for pointing to the words in each sentence plus the points earned for correctly identifying the underlined words.

Reliability

Gall, Borg, and Gall (1996) refer to test reliability as "the consistency, stability, and precision of test scores" (p. 197). Huck and Cormier (1996) affirm that reliability allows the researcher to identify the extent the data collected with the instrument are consistent. While reliability is essential to the validity of scores obtained, it cannot stand alone to indicate that inferences from scores are also valid. The developers of the PALS test addressed both criteria.

In 1997, the PALS test was administered to 52,094 kindergarten and first-grade students from varying socioeconomic-status backgrounds across eight regions in Virginia. The Virginia State Department of Education divides the state into eight regions, roughly corresponding to geographical areas, for purposes of communication (as cited in Invernizzi, et al., 1998). Cronbach's alpha was calculated to assess the estimated internal consistency of the PALS test. The indices yielded are in Table 9. The alpha coefficients were generally high, ranging from .81 for first grade to .89 for the second geographical region. According to Huck and Cormier (1996), the instrument being tested for internal reliability is considered to be better to the extent that the resulting coefficient is close to the upper limit of the possible .00 to +1.00 continuum.

Table 9

Cronbach's Alpha Coefficients for the 1997 Phonological Awareness Literacy Screening Test for Kindergarten and First Grade Students in Virginia

Variable	Group	N	Cronbach's alpha
Grade	Kindergarten	35,748	.85
	First	16,346	.81
Gender	Male	27,127	.87
	Female	24,941	.88
Socioeconomic status[a]	Low poverty	4,371	.87
	Medium-low poverty	24,995	.87
	Medium-high poverty	17,586	.88
	High poverty	4,825	.87
Geographical region[b]	1	12,537	.88
	2	10,880	.89
	3	4,826	.88
	4	5,395	.88
	5	6,015	.83
	6	5,658	.87
	7	4,484	.88
	8	2,304	.87
	Total	52,094	---

Note. Adapted from PALS Teacher's Manual (pp. 46-47), by M. Invernizzi, J. Meier, L. Swank, and C. Juel, 1998, Charlottesville, VA: University of Virginia. Copyright 1998 by The Rector and The Board of Visitors of the University of Virginia. Adapted with permission.
[a]Defined by the 1997-1998 Market Data Retrieval School Directory. Low poverty $\leq$ 5.9 % of families in school division living in poverty, Medium-low poverty = 6-15.9% of families in school division living in poverty, Medium-high poverty = 16-29.9% families in school division living in poverty, and High poverty $\geq$ 30% families in school division living in poverty.
bThe Virginia Department of Education divides the state into eight regions, roughly corresponding to geographical areas, for communication purposes.

Validity

The essence of validity is accuracy. It allows the researcher to explain how the inferences made from test scores are meaningful (Gall, Borg & Gall, 1996; Huck & Cormier, 1996). Supporting evidence for demonstrating validity of test score inferences includes: (1) content-related evidence, (2) construct-related evidence, and (3) concurrent evidence (Gall, et al.). The PALS test developers presented each type of evidence to support their claims of validity.

According to Huck and Cormier (1996), an instrument's content validity standing is normally determined "…simply by having experts carefully compare the content of the test against a syllabus or outline that specifies the instrument's claimed domain" (p. 89). Construct validity is explained as how much of a personality or psychological construct possessed by the examinees to whom the instrument is administered can be revealed by the instrument (Huck & Cormier). Conducting a factor analysis on scores from a new instrument is cited as a sophisticated statistical technique that developers may employ to establish the degree of construct validity associated with their test. Finally, concurrent validity is determined by comparing scores from a new instrument with scores on a relevant criterion variable to assess the degree to which the new instrument provides accurate measurements (Huck & Cormier).

Content Validity

According to the PALS test developers (Invernizzi, et al., 1998), items were carefully selected and based on research. Each item was expected to meet the following three attributes of measurement: (1) moderate difficulty for kindergarten and first-grade children, (2) strong predictive relationships to reading outcomes, and (3) adaptable to group assessment procedures. Revisions were made, after field-testing, with the approval of a 15-member review panel of experts appointed by the Virginia Department of Education.

The rhyme awareness task and beginning sounds task each involves the use of single-syllable, concrete words represented pictorially. The test developers chose words that had been used with preschool and primary-age children in prediction studies. They ensured that the pictures were easily recognizable and age-appropriate by having an artist draw similar renderings of pictures used successfully with preschool and primary-age children. Feedback from field-studies and panel members led the developers to: (1) clarify drawings, such as making the picture of a rock look more realistic; (2) eliminate controversial drawings, such as replacing a picture of a pipe with a picture of a bus; and (3) avoid unfamiliar items, such as replacing the picture of a fountain pen with a more contemporary version of an ink pen (Invernizzi, et al., 1998).

Test developers included all 26 alphabet letters in lowercase for the alphabet knowledge task. Uppercase letter recognition and lowercase letter recognition were reportedly significantly and highly correlated (.93 for the kindergarten sample and .90 for the first grade sample) after item-analysis from the 1997 PALS administration to 52,091 Virginia students. Thus, the more sensitive task of identifying lowercase letters was a revision included in the 1998 version of PALS.

For the letter-sound knowledge task, ample opportunity to correctly match letters with sounds is afforded students by including all but two alphabet letters in uppercase. The letters Q and X were omitted, due to the difficulty of pronouncing those letters in isolation, and were replaced with the consonant blends CH and SH, respectively. The letter M was used as an example in the task's directions and was replaced in the actual assessed task with the TH blend.

Five high-frequency words in a consonant-vowel-consonant pattern were selected for students to demonstrate application of their letter-sound knowledge in the spelling task. The spellings by 52,088 kindergarten and first-grade students in 1997 were scored by the number of phonemes represented. Because the five items proved to be the best discriminators of children in need of additional instruction in phonological awareness and early literacy, the same five words are used in the current version of the PALS test (Invernizzi, et al., 1998).

Finally, the concept-of-word task involved fingerpoint reading that required the student correctly point to each written word as the word was spoken. The original content of the text involved a farmer and a goat. Qualitative feedback indicated some children were unfamiliar with that content. The current version of PALS includes a standard nursery rhyme for this task, although familiarity with the content would not have affected the outcome of the measure according to test developers (Invernizzi, et al., 1998).

Construct Validity

Cited in the 1998 PALS Teacher's Manual is a factor analysis performed on the 1997 statewide (Virginia) PALS data as evidence for the construct validity of the instrument (Invernizzi, et al., 1998). Tasks that were common to both the kindergarten and first-grade tests were used for the factor analysis, which excludes concept of word (used for kindergarten students only) and word recognition in isolation (used for first-graders only). A one-factor solution was reported (eigenvalue = 4.42) representing the marriage of sound awareness and print awareness that is needed for reading as depicted in the PALS theoretical model. Similar statistics were reported for kindergarten data only (eigenvalue = 4.17) and for first grade data only (eigenvalue = 3.83). Invernizzi, et al., (1998) reported that 64-74% of the variance in the task scores of the entire sample, the kindergarten sample, and the first-grade sample could be accounted for by the single PALS factor and that, "the one-factor solution suggests that PALS measures a unitary trait: emergent literacy" (p. 48).

Concurrent Validity

Virginia public school students were required to take the Stanford 9 test in grades 3, 5, 8, and 11. The first grade version of this test contains tasks assessing sounds and letters, word reading, and sentence reading that are similar, though not identical, to PALS tasks. The PALS test developers (Invernizzi, et al., 1998) compared the fall 1997 performance of 127 first graders on the Stanford 9 test against the same group's

performance on the PALS test, which had been administered two weeks earlier. According to the developers (Invernizzi, et al., 1998), most of the correlations were medium to high and ranged from .67 to .81 ($p \leq .001$), demonstrating concurrent validity of PALS with Stanford 9 when administered in the first grade. The test developers noted that perfect correlations were not expected because the PALS test is an informal, criterion-referenced screening tool while the Stanford 9 is a norm-referenced tool.

Scoring

A Student Summary Sheet was used to tally the number of correct responses on each test component for individual students. The individual scores for all students were transferred to a Class Summary Sheet, and students' scores were summed across all test components, except the concept-of-word task. The test components, range of possible scores, and task benchmarks are in Table 10. The class summaries were then forwarded to the University of Virginia by electronic mail for research purposes as part of the Early Reading Intervention Initiative requirements.

Table 10

Description of Summed Scoring for Phonological Awareness Literacy Screening Tasks

Task	Maximum possible score	Kindergarten benchmarks		First-grade benchmarks	
		Fall	Spring	Fall	Spring
Group rhyme awareness[a]	10	5-8	9-10	9-10	10
Individual rhyme awareness (Pick-up rhyme pairs)	10	5-8	9-10	9-10	10
Group beginning sounds awareness	10	5-8	9-10	9-10	10
Individual beginning sound awareness[b] (Beginning sound sort)	10	5-8	9-10	9-10	10
Alphabet knowledge	26	10-20	23-25	24-25	26
Letter sound knowledge					
A. Letter sounds	26	4-12	19-23	21-24	24-25
B. Spelling	20	3-7	10-15	15-18	17-19
Concept of word					
Pointing	4	1-3	3-4	4	4
Word identification	8	2-6	4-8	6-8	8
Total	104	30-64	77-95	84-99	99-102

[a]Individual rhyme awareness was used only for individuals who scored below the benchmark on group rhyme awareness.
[b]Individual beginning sound awareness was used only for individuals who scored below the benchmark on group beginning sound awareness.

Data Collection Procedures

The PALS test may be administered to a whole class, small groups, or individual students. In this case, all kindergarten and Title I teachers were required to attend an inservice meeting prior to testing. During the meeting they viewed the video "PALS: Phonological Awareness Literacy Screening" which contained examples of how to administer each of the PALS components.

Additional instructions regarding standardized testing procedures to be used by the school system included that kindergarten teachers would administer only the group rhyme awareness and group beginning sound awareness tasks to five or fewer students at a time. All remaining PALS tasks were given by the Title I teachers, either to individual students or to groups of no more than five students. All testing was completed within two consecutive school weeks.

There were no time limits for any of the five sections of PALS (only four sections are administered to kindergarten students). For any student who did not reach benchmark scores in group rhyme awareness or group beginning sound awareness, the student was given the individual rhyme awareness pick-up rhyme pairs or individual beginning sound awareness beginning sound sort. The individual administration was given on a different day and the child's individual score was the one reported, even if it was the lower of the two scores.

Design and Methods of Analysis

A quasi-experimental approach consisting of a non-equivalent, control-group design was used in this study. The purpose of designing the study to approximate as much as possible the conditions required of a true experiment was to control for factors other than the treatment that could likely account for the results. The more the threats to internal and external validity of a quasi-experimental design are controlled, the more the results may be confidently viewed as having been actually caused by the treatment, and the more those results may be generalized to the population (Campbell & Stanley, 1963). The selected design is in Table 11 using Campbell and Stanley's notation and numbering system.

Table 11

Nonequivalent Pretest-Posttest Control Group Design

School & class	Pretest	Treatment	Posttest
A1, A3, A5, B6, B8	O_1	X	O_2
A2, A4, B7	O_1		O_2

Note. O = Phonological Awareness Literacy Screening; X = Brain Gym®;
Time between pretest and posttest was 7 months.

Internal Validity

In an experiment, randomization is key. True random assignment of individual students in a school setting is rarely feasible. Experimental conditions were approximated as much as possible in this case by randomly assigning intact classes to the treatment and control groups. Such randomization methods control for the following threats to the internal validity of the design: (1) selection bias, which is the possibility that the groups were already substantially different with regard to the dependent variable prior to any treatment exposure; (2) experimental mortality, which is the differential loss of subjects from the comparison groups once the experiment is underway; and (3) statistical regression, which is the inevitable phenomenon of extreme scorers from the sample performing closer to the population mean upon posttesting.

The quality of this study's internal validity was further strengthened by the practice of heterogeneous grouping. Students in the kindergarten classes from both populations are placed into classes based primarily on a first-come, first-assigned basis. Although parental requests for assignment of their children to a particular teacher are usually honored, such requests occur infrequently. Placement efforts are directed mainly at maintaining a balance in overall class size, gender ratios, and racial-ethnic distributions.

With the use of this design, each group has an equal chance to be affected by extraneous variables between sessions. The design controls for biological and psychological maturation effects like students growing older, more tired, or less enthusiastic. The possible effects of learning from exposure to the pretest are also equally distributed, although it is unlikely that the pretest experience alone would increase motivation or improve the attitudes and self-pacing of kindergarten-age subjects.

Within-session variations such as differences in room conditions, personalities of teachers, and wording of instructions were addressed to some degree in this study by having Title I teachers administer the majority of tasks to small groups of students. The students were pulled from their assigned kindergarten classroom for testing in the Title I

room. The Title I teachers administering the PALS test had no formal knowledge about the study, including the identity of experimental or control groups. There also was no particular order in which students were pulled for testing. These steps served to randomly distribute the effects of any unwanted situational factors among the subgroups allowing them to be ignored (Isaac & Michael, 1981).

Changing effects of instrumentation were dealt with by issuing the PALS testing booklets, answer sheets, and testing manuals to teachers and implementing testing schedules according to the inservice training given to kindergarten and Title I teachers. The kindergarten classes were not assigned to experimental or control groups until after the PALS pretest was administered, eliminating any subtle biases that may have influenced the teachers' behaviors during administration or scoring of the pretest. No changes in the test items, scoring procedures, or administration techniques occurred for the posttest sessions.

Contamination of the control group was the final threat to the internal validity of the study. Probable confounding of the design existed in the possibility that teachers and students assigned to the experimental group might share information with the teachers and students assigned to the control group within the same building. To address this threat, the researcher met with the eight kindergarten teachers involved to explain the study and stress the importance of adhering to the specified guidelines. Neither the researcher nor the teachers warned students about sharing information. The opportunity existed for children from an experimental group to talk about the treatment with students from a control group during common times such as breakfast, recess, or bus rides to and from school. Based on observations by the researcher and teachers, this either did not occur or occurred with such infrequency that it was not noteworthy. Conversations among the kindergarten children during common times at school rarely involved discussion about classroom activities of any kind. A student from the experimental group in School B asked the researcher at lunch in March 2000 how much longer his class had to do Brain Gym®.

According to Campbell and Stanley (1963), the more similar the experimental and control groups are in their recruitment, and the more this similarity is confirmed by the scores on the pretest, the more effective the Nonequivalent Control Group Pretest-Posttest Design becomes. The greatest internal validity threat distinguishing this design from a true experimental design was the possible interaction effects (i.e., selection-maturation, selection-history, or selection-testing). The second greatest was regression. Campbell and Stanley (1963) explained that if in the Nonequivalent Control Group Design, "the means of the groups [on the pretest] are substantially different, then the process of matching not only fails to provide the intended equation, but in addition insures the occurrence of unwanted regression effects" (p. 49).

A t-test was performed on the pretest scores to determine if the means of the groups were significantly different. No difference was found ($t = -1.89$, $df = 1, 124$, $p \leq .05$) between the control group's initial performance ($M = 34.67$, $SD = 18.16$, $N = 46$) and the treatment group's initial performance ($M = 41.58$, $SD = 20.53$, $N = 80$). The design employed in this study can, therefore, be considered to have adequately controlled for the effects of history, maturation, testing, and instrumentation.

External Validity

External validity is the second consideration a researcher applies to the planned design. The goal here is to answer to what degree and under what conditions the results of the study may be generalized to the represented population. Isaac and Michael (1981) named the four jeopardizing factors to external validity. First, the interaction effects of selection biases in the experimental variable, which may be categorized as population validity. The remaining three fall under the category of ecological validity: (1) reactive or interaction effects of pretesting, (2) reactive effects of experimental procedures, and (3) multiple-treatment interference.

In addressing the first of the four jeopardizing factors, the external validity of this design was strengthened by the researcher's description of the population to which the results will apply before conducting the experiment. Next, it is highly unlikely, due to

their young age, that taking the PALS pretest sensitized any of the kindergarten subjects to the Brain Gym® treatment by alerting them to issues, problems, or events they might not ordinarily notice. Similarly, the students were unaware of their status as members of an experimental or control group, and there were no observers or special equipment that might cause them to alter their normal behavior. Finally, there was only one treatment with a prescribed sequence and time-frame making multiple-treatment interference a non-threat.

A four-way analysis of variance (ANOVA) was conducted on the Phonological Awareness Literacy Screening posttest scores of sampled kindergarten students (see Figure 2). The advantages of using a factorial design over one-way designs include a greater generalizability of the results, a view of variable interactions, and fewer subjects required for the same degree of statistical power (Howell, 1985).

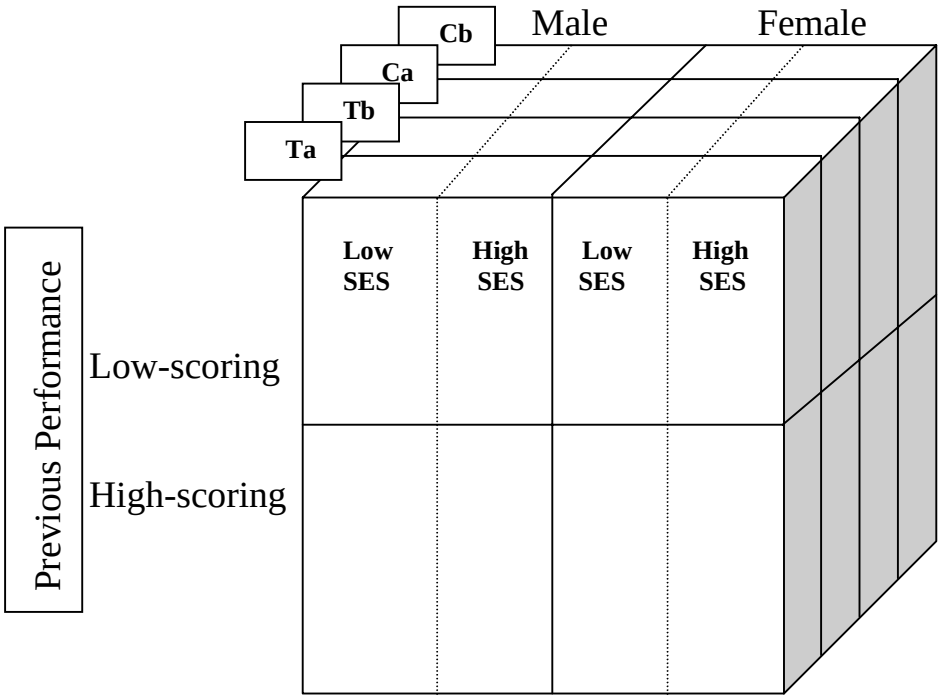

Figure 2. Groups in the four-way analysis of variance. T = treatment, C = control, a = school A, b = school B, and SES = socioeconomic status. The dependent variable is the posttest score on the Phonological Awareness Literacy Screening test.

A three-way analysis of covariance (ANCOVA) was conducted on the student groups as displayed in Figure 3. "The statistical technique of ANCOVA is used to control for initial differences between groups before a comparison of the within-groups variance and between-groups variance is made" (Gall, et al., 1996, p. 383). This control is necessary because "the main threat to the internal validity of a nonequivalent control-group design is the possibility that group differences on the posttest are due to pre-existing group differences rather than to a treatment effect" (Gall, et al., p. 508). "The nonequivalent control-group design is the most widely used quasi-experimental design in educational research" (Gall, et al., p. 507) because it is usually more feasible to randomly assign intact classes of students to treatment and control groups rather than the pure randomized assignment of each individual student. As Gall, Borg, & Gall explained, "The effect of the ANCOVA is to compensate the group with the initial disadvantage by increasing that group's posttest score to the level that would be predicted based on the correlation between pretest and posttest scores" (p. 498).

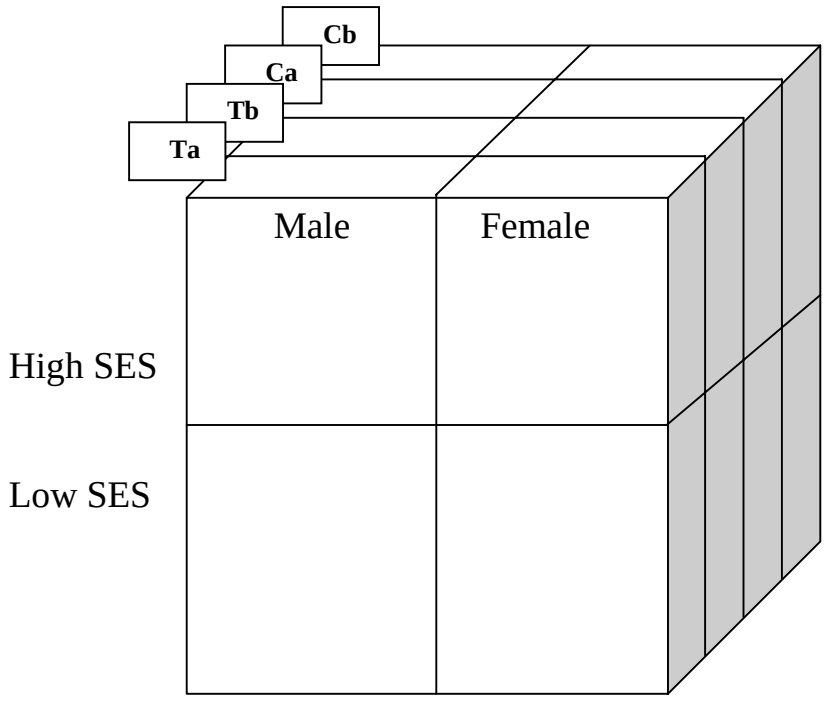

Figure 3. Groups in the three-way analysis of covariance. T = treatment, C = control, a = school A, b = school B, and SES = socioeconomic status. The covariate is the pretest score on the Phonological Awareness Literacy Screening (PALS) test. The dependent variable is the posttest score on the PALS test.

CHAPTER III
RESULTS

The effects of previous performance, gender, socioeconomic status, and participation in a program of Brain Gym® activities on students' emergent reading performance were investigated. Data were collected on similar kindergarten students from eight intact classes in two schools. Of each school's total kindergarten population, 59% from School A and 70% from School B performed the predetermined selection of six exercises from the Brain Gym® menu twice a day for approximately 28 weeks.

Measures of central tendency and dispersion are used first to describe the characteristics of the kindergarten students. Data on the comparative analyses are presented next to show the relationships between student performance on the Phonological Awareness Literacy Screening test and the variables of Brain Gym® participation, previous performance, gender, and socioeconomic status. Both descriptive and inferential statistics are presented in tables and accompanied with a narrative interpretation.

Descriptive Characteristics

The means and standard deviations of 1999-2000 pretest and posttest summed scores on the Phonological Awareness Literacy Screening test of 126 kindergarten students are in Table 12. Students in School A scored higher on the pretest and posttest in both control and treatment groups. Both control and treatment groups in both schools experienced mean score gains, ranging from a 33.77 mean point gain for the treatment group from School B to a 42.93 mean point gain for the control group from School A. Except for the control group from School B, the mean pretest score of all groups met the benchmark of 28 for the fall administration of the kindergarten PALS test. School B's treatment group, School B's control group, and males in the control group did not have mean posttest scores that reached the 74-point spring benchmark.

Table 12

Means and Standard Deviations for Sampled Kindergarten Students on the Phonological Awareness Literacy Screening Test by Group (Control v. Treatment), School, Socioeconomic Status, and Gender

Variable	Control			Treatment			Gain-score difference[a]
	N	M	SD	N	M	SD	
School A							
Pretest	31	38.42	17.79	45	43.13	20.23	
Posttest	31	81.35	7.40	45	82.93	6.53	
Gain		42.93			39.80		-3.13
School B							
Pretest	15	26.93	16.93	35	39.57	21.03	
Posttest	15	63.93	18.31	35	73.34	22.91	
Gain		37.00			33.77		-3.23
SES Low							
Pretest	30	32.83	17.21	51	37.78	19.88	
Posttest	30	74.00	16.29	51	75.94	17.85	
Gain		41.17			38.16		-3.01
SES High							
Pretest	16	38.13	19.92	29	48.24	20.27	
Posttest	16	78.81	9.88	29	83.66	12.68	
Gain		40.68			35.42		-5.26
Male							
Pretest	29	32.17	16.76	39	38.15	20.52	
Posttest	29	73.24	16.47	39	75.77	18.11	
Gain		41.07			37.62		-3.45
Female							
Pretest	17	38.94	20.12	41	44.83	20.25	
Posttest	17	79.82	9.16	41	81.56	14.49	
Gain		40.88			36.73		-4.15

[a] Difference in gain scores: treatment minus control

Kindergarten students were divided into low or high socioeconomic-status groups according to whether or not they received free or reduced-price school meals. As evident in Table 12, nearly two-thirds of the 126 students were categorized as low socioeconomic-status, 63% of whom participated in the treatment. Students in the low-socioeconomic-status control group experienced the largest gain of 41.17 points between pretest and posttest mean scores. The smallest average gain occurred in the high-socioeconomic-status treatment group with a difference of 35.42 points from pretest to posttest. The high socioeconomic-status treatment group had a mean posttest score ($\underline{M}$ = 83.66) higher than the high socioeconomic-status control group ($\underline{M}$ = 78.81). Regardless of treatment or control, the high socioeconomic-status students had better mean scores than the low socioeconomic status students on both the pretest and posttest.

Seventy-one percent of the 58 females were assigned to the treatment group along with fifty-seven percent of the 68 males. Males and females in the treatment group had higher mean posttest scores than their counterparts in the control group. Regardless of treatment or control, the females scored over five points higher on average than the males on both the pretest and posttest.

Both low and high socioeconomic-status students in the control group made greater gains between pre- and posttesting than students in the treatment group. Both males and females in the control group made greater gains between pre- and posttesting than males and females in the treatment group. Regardless of gender, socioeconomic status, or school, the control group gained on average about three points more than the treatment group.

Statistical Analyses

Fifteen research questions were generated from the variables depicted in the theoretical model (see Figure 1). Following a t-test for differences in previous performance on the Phonological Literacy Awareness Screening (PALS) test, which showed no differences between the control and experimental groups ($\underline{t}$ = -1.89, $\underline{p} \leq .05$), a 2x2x2x2 factorial analysis of variance (ANOVA) was performed to test each null hypothesis associated with the research questions. Main effects and interaction effects

were examined. The data were then examined using a three-way analysis of covariance (ANCOVA). With pretest summed scores as the covariate, the ANCOVA results of adjusted means were used to address the null hypotheses associated with seven of the original 15 research questions. Specifically, differences in adjusted PALS posttest scores were examined by Brain Gym® participation groups (treatment, control), socioeconomic status (low, high), and gender (male, female) as well as the interaction effects of the same three variables on the adjusted PALS scores.

Analysis of Variance

"The basic statistical technique used to test the null hypothesis in factorial designs is analysis of variance" (Isaac & Michael, 1981, p. 77). A four-way analysis of variance was then performed on Phonological Awareness Literacy Screening posttest summed scores to assess the significance of differences in emergent literacy skills by participation in Brain Gym® (treatment, control), previous performance (low, high), gender, and socioeconomic status (low, high). Effects for two of the fifteen null hypotheses tested were significant at alpha .05. The four-way ANOVA yielded a significant main effect for previous performance and non-significant main effects for Brain Gym® participation, socioeconomic status, and gender. A significant interaction effect was found only for Brain Gym® participation, socioeconomic status, and gender.

Table 13

Decisions Tied to Null Hypotheses

Null hypothesis	Decision	
	ANOVA	ANCOVA
1. Brain Gym® participation groups (treatment, control) do not differ on PALS scores.	Fail to reject	Fail to reject
2. Previous performance groups (low, high) do not differ on PALS scores.	Reject	N/A
3. Socioeconomic status groups (low, high) do not differ on PALS scores.	Fail to reject	Fail to reject
4. Gender groups (male, female) do not differ on PALS scores.	Fail to reject	Fail to reject
5. There is no interaction effect of Brain Gym® participation and previous performance on PALS scores.	Fail to reject	N/A
6. There is no interaction effect of Brain Gym® participation and socioeconomic status on PALS scores.	Fail to reject	Fail to reject
7. There is no interaction effect of Brain Gym® participation and gender on PALS scores.	Fail to reject	Fail to reject
8. There is no interaction effect of previous performance and socioeconomic status on PALS scores.	Fail to reject	Fail to reject
9. There is no interaction effect of previous performance and gender on PALS scores.	Fail to reject	N/A
10. There is no interaction effect of socioeconomic status and gender on PALS scores.	Fail to reject	Fail to reject

(table continues)

Table 13 (continued)

Decisions Tied to Null Hypotheses

Null hypothesis	Decision	
	ANOVA	ANCOVA
11. There is no interaction effect of Brain Gym® participation, previous performance, and socioeconomic status on PALS scores.	Fail to reject	N/A
12. There is no interaction effect of Brain Gym® participation, previous performance, and gender on PALS scores.	Fail to reject	N/A
13. There is no interaction effect of Brain Gym® participation, socioeconomic status, and gender on PALS scores.	Reject	Fail to reject
14. There is no interaction effect of previous performance, socioeconomic status, and gender on PALS scores.	Fail to reject	N/A
15. There is no interaction effect of Brain Gym® participation, previous performance, socioeconomic status, and gender on PALS scores.	Fail to reject	N/A

Significant differences were found (F = 17.25, df = 1, 110, p = .001) in the emergent literacy posttest performance of students depending upon their pretest performance. The ANOVA source table for this finding is in Table 15. Those students in the high previous-performance group achieved higher scores on the posttest (M = 82.52, SD = 10.16, N = 85) than those from the low previous-performance group (M = 67.46, SD = 20.17, N = 41). The main effect tests for Brain Gym® participation, socioeconomic status, and gender did not yield significant results (see Table 14).

A significant three-way interaction effect was found (F = 6.13, df = 1, 110, p = < .05) on emergent literacy performance by Brain Gym® participation (treatment, control), socioeconomic status (low, high), and gender. For students identified as high previous-performers based on their pretest scores, low socioeconomic-status males in the treatment group scored higher (M = 80.13, SD = 13.44, N = 4) than low socioeconomic-status males in the control group (M = 79.17, SD = 6.25, N = 12). High socioeconomic-status females in the treatment group scored higher (M = 88.79, SD = 8.01, N = 14) than high socioeconomic-status females in the control group (M = 80.75, SD = 0.96, N = 4).

A similar pattern appeared for students identified as low previous-performers. Those males who were also low socioeconomic-status and in the treatment group scored higher (M = 66.73, SD = 24.27, N = 11) than their counterparts in the control group (M = 55.88, SD = 21.61, N = 8). The high socioeconomic status females in the treatment group scored higher (M = 82.00, SD = 12.73, N = 2) than the high socioeconomic-status females in the control group (M = 70.33, SD = 17.90, N = 3). Females in the treatment group with high previous-performance scores from high socioeconomic-status backgrounds were the overall highest scorers (M = 88.79, SD = 8.01, N = 14).

Table 14

Means and Standard Deviations for Sampled Kindergarten Students on the Phonological Awareness Literacy Screening Test by Cells in the Four-Way Analysis of Variance

Variable		Control		Treatment	
		High SES	Low SES	High SES	Low SES
Previous Performance					
High					
Male	M	83.25	79.17	83.20	80.13
	SD	9.03	6.25	5.75	13.44
	N	4	12	10	15
Female	M	80.75	85.14	88.79	80.79
	SD	0.96	4.56	8.01	13.57
	N	4	7	14	19
Low					
Male	M	78.80	55.88	62.33	66.73
	SD	8.17	21.61	27.06	24.27
	N	5	8	3	11
Female	M	70.33	75.67	82.00	67.00
	SD	17.90	5.03	12.73	20.40
	N	3	3	2	6

Table 15

ANOVA Table for Differences in Phonological Awareness Literacy Screening Scores of Kindergarten Students by Group (Treatment v. Control), Previous Performance, Socioeconomic Status, and Gender

Source	SS	df	MS	F	p
Group (A)	1.27	1	1.27	.01	.94
Previous performance (B)[a]	3388.51	1	3388.51	17.25	.01
Socioeconomic status (C)[b]	489.50	1	489.50	2.50	.18
Gender (D)	541.88	1	541.88	2.76	.10
A x B	16.79	1	16.79	.09	.77
A x C	6.21	1	6.21	.03	.86
A x D	41.78	1	41.78	.21	.65
B x C	98.18	1	98.18	.50	.48
B x D	149.78	1	149.78	.76	.38
C x D	49.70	1	49.70	.25	.62
A x B x C	108.73	1	108.73	.55	.46
A x B x D	11.04	1	11.04	.06	.81
A x C x D	1202.81	1	1202.81	6.13	.02
B x C x D	9.12	1	9.12	.05	.84
A x B x C x D	378.39	1	378.39	1.93	.17
Within	21602.73	110	196.39		
Total	790332.00	126			

[a] Low previous-performance group scored < 28 on PALS pretest and high previous performance group scored ≥ 28.
[b] Low socioeconomic-status group received free or reduced-price school meals and high socioeconomic-status group did not.

Summary

A significant main effect for previous performance was found. Students who were categorized as high previous-performers based on prettest scores were also high posttest performers. There were no differences found for Brain Gym® participation, gender, or socioeconomic status on emergent literacy skills as measured by the Phonological Awareness Literacy Screening posttest.

While no statistically significant differences existed between treatment and control groups, males and females, or low and high socioeconomic-status groups, a significant interaction effect was found on posttest performance for Brain Gym® participation, gender, and socioeconomic status. Whether in the low or high previous-performance category, low socioeconomic-status males and high socioeconomic-status females who participated in the Brain Gym® treatment scored higher in emergent literacy achievement than did their counterparts in the control group.

Analysis of Covariance

Using the pretest summed scores on the Phonological Literacy Awareness Screening test as the covariate, a three-way analysis of covariance was performed on the data to assess differences in adjusted posttest mean scores across the variables. After adjusting for previous performance, no differences were found for Brain Gym® participation (treatment, control), socioeconomic status (low, high), or gender. There were no interaction effects found among these same variables. The ANCOVA results are in Table 16.

Table 16

ANCOVA Table for Differences in Adjusted Phonological Awareness Literacy Screening Scores of Kindergarten Students by Group (Treatment v. Control), Socioeconomic Status, and Gender

Source	SS	df	MS	F	p
Group (A)	.14	1	.14	.01	.98
Socioeconomic Status (B)[a]	138.69	1	138.69	.74	.39
Gender (C)	198.33	1	198.33	1.06	.31
A x B	41.01	1	41.01	.22	.64
A x C	13.32	1	13.32	.07	.79
B x C	193.85	1	193.85	1.04	.31
A x B x C	432.36	1	432.36	2.32	.13
Covariate[b]	5870.03	1	5870.03	31.44	.01
Within	21848.33	117	186.74		
Total	790332.00	126			

[a] Low socioeconomic-status group received free or reduced-price school meals and high socioeconomic-status group did not.
[b] PALS pretest summed score.

CHAPTER IV
CONCLUSIONS, DISCUSSION, IMPLICATIONS FOR PRACTICE, AND RECOMMENDATIONS FOR FUTURE RESEARCH

In this section, generalizations derived from the findings are presented. Possible reasons why findings support or fail to support the hypotheses are discussed followed by implications for practice in the field of education. Finally, suggestions are made for future research.

Conclusions

Significant results in five areas were in this study by the researcher. The main effect expectations were (1) participation in Brain Gym® would improve kindergarten students' posttest performance on the PALS test, (2) those students who met or exceeded the benchmark score on the pretest would also be the ones to score higher on the posttest, (3) females would score higher than males, and (4) students in the low socioeconomic-status group would score lower than those in the high socioeconomic-status group. The only expected interaction was that students with low pretest scores who experienced the Brain Gym® treatment would score better on the posttest than those students who had low pretest scores and did not receive the treatment.

Two of the fifteen null hypotheses were supported. The first is that students who score high on the pretest can indeed be expected to score high on the posttest. Earlier research demonstrated that previous performance is one of the best predictors of future success. The findings in this study add support to that claim. The second was the only interaction found, which had less to do with previous performance than with gender and socioeconomic status. Specifically, participation in Brain Gym® may afford some academic benefits to low socioeconomic-status males and high socioeconomic-status females. Previous research findings suggested that the benefits of Brain Gym® were evident regardless of gender. Findings in this study suggest that the benefits of Brain Gym® may be gender-specific when considered with socioeconomic status.

Summary

The findings of this study fail to support the overall effectiveness of Brain Gym® exercises for enhancing the learning-to-read skills acquired by kindergarten students during one school year. The findings fail to support a difference in the performance of males and females or low and high socioeconomic-status groups. Females did not score higher than males, nor did financially advantaged students outperform financially disadvantaged students on the PALS test.

The data lend support to the notion that a few minutes spent performing Brain Gym® activities each day may be of some academic benefit to males from low socioeconomic-status families and females from high socioeconomic-status families. Practically, those same groups of students would probably benefit much more by spending a similar amount of time engaged in an instructionally sound activity.

Discussion

The interpretation of the results from this study may be limited in several ways. First, low sample size was an issue. The number of students represented in certain ANOVA cells displayed in Table 13 may not have been adequate for the analysis. Specifically, there were only 2 females in the low previous-performance, high socioeconomic-status treatment group and 3 females in the low previous-performance, high socioeconomic-status control group. Of sixteen cells, ten had fewer than ten students.

Secondly, the overall student demographics seemed matched closely enough, although the percentages of black and white students in School B were more evenly distributed than in School A, but the implementation of the curriculum may have been substantially different between the schools. The experience levels among teachers may have been a telling factor. Results pointing to these possible limitations include the higher gains in School A and overall lower performance of the control group in School B. The hint at differences between schools and among teachers warrants pursuit, but these variables were not included in this study's design.

A third possibility for insignificant results may have been the selection of exercises from the Brain Gym® menu. Would performing a different series of exercises have led to different results? Should a certain exercise immediately precede a certain classroom activity and then the same exercise be performed immediately before the administration of a corresponding PALS task?

Another unusual result is no main effect for Brain Gym® although that variable appears to play a part in the interaction according to these findings. When the ANCOVA is used, a good covariate should correlate highly with the dependent variable, but not with the independent variables. In this case, previous performance was used as the covariate, which does highly correlate with posttest performance but may also be too closely linked with socioeconomic status. No significant results were found after adjusting means for previous performance.

Summary

The unusual findings and limitations of this study combine to lessen the confidence with which the researcher may make generalizations. The quasi-experimental research design allows the reasonable conclusion that the significant outcomes were created by the treatment. Although it may be reasonable to conclude the results were due to the treatment, the findings may have been merely random. Howell (1985) explained that unequal sample sizes present problems for the researcher who employs a factorial design versus a one-way ANOVA. The difficulties are that considerably more complicated calculations are required and the interpretations of the results can be very unclear (Howell, p. 264). This particular challenge may have been overcome by using the Statistical Package for the Social Sciences (SPSS) to perform the analyses. Howell said, "Unless you make a deliberate change to the available options, SPSS, Minitab, and JMP will provide you with the analyses you want" (p. 348). Still, the small and unequal sample sizes of each ANOVA cell are not the optimal situation and make it difficult to be confident in the results.

Dennison and Dennision (1985) suggested that, when the two hemispheres of the brain are working in harmony, individuals could function in a more integrated and

coordinated manner. Dennison (1981) recommended educational kinesiology techniques of simple, specific body movements to integrate the functions of the brain, balance the body system for more energy, and reduce stress. Khalsa et al. (1988) and Sifft et al. (1991) found improvements by students on perceptual-motor skills such as balance and visual response times after use of Brain Gym® techniques. Travis (1989) found no improvements in the perceptual motor skills by participants on typewriting speed and typewriting accuracy while Cammisa (1994) found improvements by students on perceptual motor skills but no improvements on academic skills. More academic criteria were used in this study than have been used in previous studies pertaining to Brain Gym®. Is Brain Gym® the correct tool to use for improving physical aspects of learning to read, such as visual tracking or auditory discrimination? Perhaps the Brain Gym® techniques are only useful for improving perceptual-motor skills for a short time, or perhaps the conceptual leap is too big to say that the improvements will carry over to physiological aspects of learning to read.

Maybe the implementation of the Brain Gym® exercises is the issue that led to the unexpected results. This study was initiated to test the tenets of Brain Gym® in a real-world setting – one having the practical backdrop of selecting effective early reading interventions, as school accountability rises and the need to have strong, independent readers by the end of third grade becomes imperative. Certain Brain Gym® exercises might need to be performed immediately preceding a specific phonological awareness or literacy instructional activity. Would it be beneficial, for example, to perform Double Doodles prior to the specific task of identifying lowercase alphabet letters or to have students practice Lazy Eights just before asking them to finger-point to words that are being read aloud to them? More standardization in the implementation of the exercises across classrooms might be needed. Should every classroom teacher require students to be seated while drawing their Double Doodles on a horizontal surface or to stand while drawing on a vertical surface? Should tally sheets of students' participation in exercises be maintained? Should a certified Educational Kinesiology consultant direct the Brain Gym® program?

Implications for Practice

This study has implications for public educators across Virginia as they continue to confront demands for higher levels of accountability for student achievement in a challenging budgetary and scheduling environment. While the Brain Gym® program did not cost the school system monetarily, there were opportunity costs associated with its use. The greatest implication for practice is for school personnel to beware the temptation of elixirs in attractive bottles.

Because the benefits of Brain Gym® are so nebulous, administrators responsible for educational programming and staff development should adopt a wait-and-see attitude. Through reading, attending conferences, and networking, teachers are likely to continue having their interest in Brain Gym® piqued as a unique way to address their stressful challenges. The results of this study indicate an administrative responsibility to steer teachers away from implementing this program as an academic intervention strategy. Until more empirical evidence substantiates the purported academic benefits of Brain Gym®, human and financial resources of schools should be focused on using something more clearly researched as producing desirable results.

Recommendations for Future Research

This study serves to bring the purported benefits of Brain Gym® out of the primarily anecdotal realm from which it receives most of its acclaim. Claims made by supporters of the Educational Kinesiology Foundation and by authors published in the Brain Gym® Journal need to be further scrutinized with quantitative research. "In educational assessment and decision-making, [research] is the only way to make rational choices between alternative practices, to validate educational improvements, and to build a stable foundation of effective practices as a safeguard against faddish but inferior innovations" (Foreword, Isaac, 1981).

A common phrase in this section of dissertations is that more questions were raised than answered as a result of conducting the study. This one is no exception. Based on small numbers and unequal groups, the study could be replicated using larger,

more equally distributed numbers of students. It would be especially important to look again at the two groups of students who showed some benefits in this endeavor, that is the low socioeconomic-status males and high socioeconomic-status females.

Do these findings hold? If so, further breakdowns might be useful. For example, do the high socioeconomic-status females benefit more from performing the Double Doodles exercise while the low socioeconomic-status males experience gains on paper-and-pencil tests after having performed Cross Crawls? Small, experimental studies would be useful especially if related to specific tasks on PALS. Does one or more treatments of Brain Gym® benefit the speed of a student's alphabet recognition or improve a student's accuracy in discriminating rhyming words? Is more than 28 weeks of treatment needed with students of such a young age?

I see some personal benefits as purely a relaxation technique when used prior to an interview or presentation. I have witnessed the calming effects when used by an occupational therapist with an agitated developmentally-delayed child. Another study might be undertaken to see if it is beneficial to use the Brain Gym® exercises with students as a relaxation tool to reduce test anxiety or alleviate apprehensions about presenting orally before peers. An extension of that idea is to consider whether the techniques are useful with children as a calming technique at all. If so, should the exercises be relegated only to more social aspects of a student's day, such as during a conflict mediation or de-escalation of a fight?

Some academic benefits were found in this study for high socioeconomic-status females and low socioeconomic-status males. Students in these categories are often described by classroom teachers as inattentive or overactive. Did performing Brain Gym® exercises help these students relax and focus on the instructional activities that followed? Is that in itself a worthwhile outcome regardless of test scores?

While the intuitive appeal of educational kinesthetics may be tempting to teachers in search of solutions, this appeal must be tempered by the fact that it has not yet received the empirical support necessary to deem the technique a viable intervention option. The number and complexity of interrelationships among physiological and cognitive processes in learning to read, the problems associated with measuring these processes, and the difficulties in matching instructional methods across classrooms are issues that need further exploration. In the meantime, educators need to continue considering both the economic and opportunity costs of implementing interventions for improving student achievement. If nothing else, this study serves as a reminder that passion and packaging should not be substitutes for substance and statistical evidence.

REFERENCES

Abland, K.E., & Lipshultz, R.E. (1998). Self-regulated learning in high achieving students: Relations to advanced reasoning, achievement goals, and gender. Journal of Educational Psychology, 90 (1), 94-101.

Adams, M.J. (1990). Beginning to read: Thinking and learning about print. Cambridge, MA: Massachusetts Institute of Technology.

Annett, M., & Kilshaw, D. (1982). Mathematical ability and lateral asymmetry. Cortex,18, 547-568.

Armstrong, T. (1994). Multiple intelligences: Seven ways to approach curriculum. Educational Leadership, 52 (3), 26-28.

Armstrong, T. (1996). A holistic approach to Attention Deficit Disorder. Educational Leadership, 53 (5), 34-36.

Ascher, C. (1990). Assessing bilingual students for placement and instruction (Report No. RI 88062013). Washington, DC: Office of Educational Research and Improvement, U.S. Department of Education. (ERIC Document Reproduction Service No. ED 322273)

Asher, S. R., & Markell, R. A. (1974). Sex differences in comprehension of high and low-interest reading material. Journal of Educational Psychology, 66, 680-687.

Blom, G. E. (1971). Sex differences in reading disability. In E. Calkins (Ed.), Reading forum. Bethesda, MD: National Institute of Neurological Disease and Stroke.

Blythe, T., & Gardner, H. (1990). A school for all intelligences. Educational Leadership, 47 (7), 33-37.

Brown, B. W. (1991). How gender and socioeconomic status affect reading and mathematics achievement. Economics of Education Review, 10, 343-356.

Bower, B. (1992). Left brain may serve as language director. Science News, 141, 149.

Bower, B. (1996). Right brain takes memory personally. Science News, 150, 5.

Brooks, S. S. (1922). Some uses for intelligence tests. Journal of Educational Research, 5 (3), 217-238.

Burt, J. J. (1998). The role of kinesiology in elevating modern society. The Sixth Delphine Hanna Interdisciplinary Lecture (1997). Quest, 50, 80-95.

Byrne, B., & Fielding-Barnsley, R. (1993). Evaluation of a program to teach phonemic awareness to young children: A one-year follow up. Journal of Educational Psychology, 85 (1), 104-111.

Cammisa, K. M. (1994). Educational kinesiology with learning disabled children: An efficacy study. Perceptual and Motor Skills, 78, 105-106.

Campbell, K.S. (1990). The oral language acquisition analogy in early literacy research. Educational Research Quarterly, 14 (3), 45-50.

Campbell, D., & Stanley, J. (1963). Experimental and quasi-experimental designs for research. Chicago: Rand McNally.

Childs, R. A. (1990). Gender bias and fairness (Report No. R 88062003). Wahington, DC: Office of Educational Research and Improvement, U.S. Department of Education. (ERIC Document Reproduction Service No. ED 328610)

Clifton, M.A. (1978). Effects of special instruction and practice by preschool-age children on performance of object projection and stability tests. Perceptual and Motor Skills, 47, 1135-1140.

Cooper, H., Lindsay, J.J., Nye, B., & Greathouse, S. (1998). Relationships among attitudes about homework, amount of homework assigned and completed, and student achievement. Journal of Educational Psychology, 90 (1), 70-83.

Dennison, P. E. (1981). Switching on: A guide to Edu-Kinesthetics. Ventura: Edu-Kinesthetics, Inc.

Dennison, P. E., & Dennison, G. E. (1985). Personalized whole brain integration. Ventura: Edu-Kinesthetics, Inc.

Dennison, P. E., & Dennison, G. E. (1986). Brain Gym®. Ventura: Edu-Kinesthetics, Inc.

Dennison, P. E., & Dennison, G. E. (1987). Edu-K for kids. Ventura: Edu-Kinesthetics, Inc.

Dennison, P. E., & Dennison, G. E. (1994). Brain Gym®: Teacher's edition revised. Ventura: Edu-Kinesthetics, Inc.

Dennison, G., & Pourroy, J. (Eds.). (1999, April). Brain Gym® Journal. (Available from the Educational Kinesiology Foundation, 1691 Spinnaker Dr., Suite 105B, Ventura, CA 93001)

DePauw, K. P. (1998). Futuristic perspective for kinesiology and physical education. Quest, 50, 1-8.

Diamond, S. (1999). Research: Brain Gym® in British Columbia. Brain Gym® Journal, 13 (1), 6-7.

Ditunno, P. L., & Mann, V. A. (1990). Right hemisphere specialization for mental rotation in normals and brain-damaged subjects. Cortex, 26, 177-188.

Dwyer, C. A. (1973). Sex differences in reading: An evaluation and a critique of current theories. Review of Educational Research, 43, 455-466.

Dwyer, C. A. (1974). Influence of children's sex role standards on reading and arithmetic achievement. Journal of Educational Psychology, 66, 811-816.

Gage, R. (1995). Excuse me, you're cramping my style: Kinesthetics for the classroom. English Journal, 84 (8), 52-55.

Gall, M., Borg, W., & Gall, J. (1996). Educational research: An introduction (6th ed.). New York: Longman.

Gardner, H. (1990a). The difficulties of school: Probable causes, possible cures. Daedalus, 119 (119), 85-113.

Gardner, H. (1990b). National education goals and the academic community. The Education Digest, 55 (6), 41-43.

Gardner, H. (1993a). Educating for understanding. The American School Board Journal, 180 (7), 20-24.

Gardner, H. (1993b). Multiple intelligences: The theory in practice. New York: Basic Books.

Gardner, H. (1995a). Limited visions, limited means: Two obstacles to meaningful educational reform. Daedalus, 124 (4), 101-105.

Gardner, H. (1995b). Multiple intelligences as a catalyst. English Journal, 84 (8), 16-18.

Gardner, H. (1995c). Why would anyone become an expert? The American Psychologist, 50 (9), 802-803.

Gardner, H. (1998). Is musical intelligence special? The Choral Journal, 38 (8), 23-34.

Gardner, H. (1999). Intelligence reframed: Multiple intelligences for the 21st century. New York: Basic Books.

Gates, A. I. (1961). Sex differences in reading ability. The Elementary School Journal, 61, 431-434.

Geschwind, N., & Behan, P. (1982). Left-handedness: Association with immune disease, migraine, and developmental learning disorder. Proceedings of the National Academy of Science, USA, 79, 5097-5100.

Geschwind, N., & Levistky, W. (1968). Human brain: Left-right asymmetries in temporal speech region. Science, 161, 186-187.

Hadar, U., Ticehurst, S., & Wade, J. P. (1991). Crossed anomic aphasia: Mild naming deficits following right brain damage in a dextral patient. Cortex, 27, 459-468.

Hannaford, C. (1995). Smart moves: Why learning is not all in your head. Arlington, VA: Great Ocean Publishers, Inc.

Harrington, T. F. (1995). Assessment of abilities (Report No. RR 93002004). Washington, DC: Office of Educational Research and Improvement, U.S. Department of Education. (ERIC Document Reproduction Service No. ED 389960)

Hatch, T., & Gardner, H. (1990). If Binet had looked beyond the classroom: The assessment of multiple intelligences. International Journal of Educational Research, 14 (5), 415-429.

Holbrook, H. T. (1988). Sex differences in reading: Nature or nurture? Journal of Reading, 2 (1), 574-576.

Howell, D. (1985). Fundamental statistics for the behavioral sciences. Boston, MA: PWS Publishers.

Huck, S., & Cormier, W. (1996). Reading statistics and research (2nd ed.). New York: HarperCollins.

Hylton, J., & Hartman, S. (1996). The learning styles of medical students: An annotated bibliography of twenty years research. Perceptual and Motor Skills, 83, 1411-1420.

Invernizzi, M., Meier, J., Swank, L., Juel, C., The Virginia State Department of Education, & The University of Virginia Curry School of Education. (1998). Phonological awareness literacy screening: Teacher's manual. Charlottesville, VA: University of Virginia.

Isaac, S., & Michael, W. (1981). Handbook in research and evaluation (2nd ed.). San Diego, CA: EdITS.

Johnson, G. B. (1939). A study of the relationship that exists between physical skill, as measured, and the general intelligence of college students. Research Quarterly, 3 (1), 57-59.

Kaplan, J. A., Brownell, H. H., Jacobs, J.R., & Gardner, H. (1990). The effects of right hemisphere damage on the pragmatic interpretation of conversational remarks. Brain and Language, 38 (2), 315-333.

Khalsa, G. K., Morris, G. S. D., & Sifft, J. M. (1988). Effect of educational kinesiology on static balance of learning disabled students. Perceptual and Motor Skills, 67, 51-54.

Kornhaber, M., Krechevsky, M., & Gardner, H. (1990). Engaging intelligence. Educational Psychologist, 25 (3-4), 177-199.

Lanham III, J.W. (1999). Relating building and classroom conditions to student achievement in Virginia's elementary schools. Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University, Blacksburg, VA.

Lezotte, L.W., & Passalacqua, J. (1978). Individual school buildings: Accounting for differences in measured pupil performance. Urban Education, 13 (3), 283-293.

Li, J., & Gardner, H. (1993). How domains constrain creativity: The case of traditional Chinese and Western painting. The American Behavioral Scientist, 37 (1), 94-101.

Mackey, B., Johnson, R., & Wood, T. (1995). Cognitive and affective outcomes in a multi-age language arts program. Journal of Research in Childhood Education, 10 (1), 49-61.

Macklem, G. L. (1990). Measuring aptitude. (Report No. R 88062003). Washington, DC: Office of Educational Research and Improvement, U.S. Department of Education. (ERIC Document Reproduction Service No. ED 3286808)

McManus, I. C., & Bryden, M. P. (1991). Geschwind's theory of cerebral lateralization: Developing a formal, causal model. Psychological Bulletin, 110 (2), 237-253.

O'Sullivan, J. T. (1992). Reading beliefs and reading achievement: A developmental study of students from low-income families (Report No. CS 011 214). Ottawa: National Literacy Secretariat. (ERIC Document Reproduction Service No. ED 354 505)

Park, H., Bauer, S., & Sullivan, L. (1998). Gender differences among top performing elementary students in mathematical ability. Journal of Research and Development in Education, 31 (3), 133-141.

Pinter, R., & Noble, H. (1920). The classification of school children according to mental age. Journal of Educational Research, 2 (4), 713-738.

Quintero, E., & Huerta-Macias, A. (1995). Bilingual children's writing: Evidence of active learning in social context. Journal of Research in Childhood Education, 9 (2), 157-164.

Rarick, G. L., Widdop, J. H., & Broadhead, G. D. (1970). The physical fitness and motor performance of educable mentally retarded children. Exceptional Children, 25, 509-519.

Rehak, A., Kaplan, J. A., & Gardner, H. (1992). Sensitivity to conversational deviance in right-hemisphere-damaged patients. Brain and Language, 42 (2), 203-217.

Ross, E. D., Thompson, R. D., & Yenkosky, J. (1997). Lateralization of affective prosody in brain and the callosal integration of hemispheric language functions. Brain and Language, 56 (1), 27-54.

Ruta, P. (1999). My discovery of Brain Gym® and Accelerative Learning. Brain Gym® Journal, 13 (1), 4-5.

Schratz, M., & Mehan, H. (1993). Gulliver travels into a math class: In search of alternative discourse in teaching and learning. International Journal of Educational Research, 19 (3), 247-264.

Selkoe, D. (1992). Aging brain, aging mind. Scientific American, 267 (3), 134-142.

Sheridan, E. M., & Fitzdale, B. (1981). Cultural factors and sex differences in reading and mathematics. (ERIC Document Reproduction Service No. ED 205-936)

Sifft, J.M., & Khalsa, G.C.K. (1990). Effect of educational kinesiology on hearing. [Abstract from Experimental Research on Educational Kinesiology.] Ventura, CA: Educational Kinesiology Foundation.

Sifft, J. M., & Khalsa, G. C. K. (1991). Effect of educational kinesiology upon simple response times and choice response times. Perceptual and Motor Skills, 73, 1011-1015.

Snow, C.E. (1991). The theoretical basis for relationships between language and literacy development. Journal of Research in Childhood Education, 6 (1), 5-19.

Solley, B. (1992). Affective variables as related to writing education. Educational Research Quarterly, 15 (1), 21-33.

Stein, A. H., & Smithells, J. (1969). Age and sex differences in children's sex-role standards about achievement. Developmental Psychology, 1, 252-259.

Steiner, E. E., Steinen, R. F., & Newman, I. (1981, April). A current investigation of sex differences in reading achievement and the sex typing of reading. Paper presented at the annual meeting of the American Educational Research Association, Los Angeles, CA.

Thorkildsen, T.A., & Nicholls, J.G. (1998). Fifth graders' achievement orientations and beliefs: Individual and classroom differences. Journal of Educational Psychology, 90 (2), 179-201.

Thorndike, R. L. & Hagen, E. (1955). Measurement and evaluation in psychology and education. 3rd ed. New York: Joahn Wiley & Sons, Inc.

Travis, N. J. (1989). The effects of educational kinesiology and functional visual efficiency on typewriting speed and accuracy. Unpublished doctoral dissertation, Virginia Polytechnic Institute and State University, Blacksburg, VA.

Trepanier-Street, M.L., Romatowski, J.A., & McNair, S. (1990). Children's written responses to stereotypical and non-stereotypical story starters. Journal of Research in Childhood Education, 5 (1), 60-68.

Wang, A.Y. (1993). Cultural-familial predictors of children's metacognitive and academic performance. Journal of Research in Childhood Education, 7 (2), 83-89.

Williams, A. (1989). Class, race, and gender in American education. Paper presented at the annual meeting of the College Reading Association, Philadelphia, PA. (ERIC Document Reproduction Service No. ED 344 907)

Appendix A

Summary of Literature Reviewed

Author(s) & year	Conclusions	Analytic method	N
Annett & Kilshaw, 1982	Suggests incidence of left-handed preference and skill slightly raised in mathematicians not due to intrinsic advantage of left preference but disadvantaged math thinking in extreme right bias.	χ^2, t-test	124
Armstrong, 1994	Advocates linking all instructional objectives to Gardner's multiple intelligences for maximum learning.	Personal account	N/A
Armstrong, 1996	Advocates use of multiple intelligences approaches as effective for capitalizing on strengths of ADHD children.	Literature review	N/A
Ascher, 1990	Scores of bilingual students on educational and psychological tests underestimate learning capacity.	Literature review	N/A
Blythe & Gardner, 1990	Offers personal vision of what schools based on Gardner's MI theory might look like; brief descriptions of current pilot studies.	Personal visions	N/A
Bower, 1992	Left hemisphere handles specific characteristics of language, rather than muscle movements or symbolic abilities involved in language, including signing.	Experiment review	77
Bower, 1996	Ability to revive autobiographical recollections located mainly in right hemisphere, with "hub" in temporal cortex.	Brain scan blood flow	7

(appendix continues)

Appendix A (continued)

Summary of Literature Reviewed

Author(s) & year	Conclusions		Analytic method	N
Brooks, 1922	Intelligence is determined through heredity. Group intelligence testing should be used by schools so teachers can stop wasting the time of brighter children.	Descriptive	592 comparisons of IQ scores	
Burt, 1998	Role of kinesiology is to elevate society by providing citizens opportunities to achieve well-being and avoid preventable diseases, premature death, and violence.		Dialogue	N/A
Cammisa, 1994	Suggested an educational kinesiology program improved perceptual motor skills of specific learning disabled students but had no significant effect on academic improvement.		t-test	25
Childs, 1990	Gender bias and gender fairness are complex issues that must be addressed with any use of standardized testing.		Literature review	N/A
Clifton, 1978	Performance of the overhand throw by preschool-age children can be improved beyond maturational expectations through guided instruction.		ANCOVA	96

(appendix continues)

Appendix A (continued)

Summary of Literature Reviewed

Author(s) & year	Conclusions	Analytic method	N
DePauw, 1998	Universities must change from teaching to learning paradigm that understands mind-body connection and moves from elitism to pursuit of excellence in all.	Opinion	N/A
Ditunno & Mann, 1990	Two experiments demonstrate right hemisphere of brain advantaged for mental rotation (a visual-spatial task).	ANOVA	40 and 12
Gage, 1995	Kinesthetic learners comprise 15% of the student population and need to have learning activities designed for their often overlooked strength.	Personal account	N/A
Gardner, 1990a	Brief comparison of Chinese education tied to national standards and performance goals v. American's pluralistic approach to education.	Informal observations	N/A
Gardner, 1990b	Suggested the need for individualized form of education in America. Envisioned blending traditional and progressive approaches with apprenticeships to yield reasonable levels of literacy, numeracy, and critical thinking skills for all students.	Opinion	N/A
Gardner, 1993	Uses vignettes to illustrate need for multiple intelligences approach to forge bridges to understanding in restructuring schools; mentions work of Project Zero at Harvard and ATLAS through New American Schools Development Corporation.	Personal vision and mention of Pilot projects	N/A

(appendix continues)

Appendix A (continued)

Summary of Literature Reviewed

Author(s) & year	Conclusions	Analytic method	N
Gardner, 1995a	Meaningful educational reform being blocked by parents and practitioners operating as mutually exclusive groups perpetuated by media and politics.	Opinion	N/A
Gardner, 1995b	Discussion of "surface" vs. "deep" applications of his MI theory.	Critique	N/A
Gardner, 1998	Urges that ideas about multiple intelligences be used to facilitate "crystallizing experiences" for children, of which music plays a vital part for many. Admonishes use of multiple intelligences theory to label or dismiss people or to create more tests that foster either.	Transcript of talk arguing vision	N/A
Geschwind & Behan, 1982	Two survey studies revealed higher frequencies of immune disease, migraine, and developmental learning disorders among left-handers.	χ^2	506, 994
Geschwind & Levistky, 1968	Planum temporale, part of temporal speech cortex, is larger on left side of brain than on right.	Linear measurements	100 brains
Hadar et al., 1991	Supports emerging suggestions that reversal of normal pattern of hemispheric specialization is possible.	Case study	1

(appendix continues)

Appendix A (continued)

Summary of Literature Reviewed

Author(s) & year	Conclusions	Analytic method	N
Harrington, 1995	Use of self-assessment methodologies tap more ability areas than existing ability or aptitude tests, are cost-effective and useful for self-knowledge and career planning, are at least of comparable validity with more traditional approaches. May be too lenient to be accurate.	Literature review	N/A
Hatch & Gardner, 1990	Intelligence-fair, contextualized assessments are required in schools to gauge ability and document its development; reasoning processes among individuals engaged in meaningful activity are more different than alike.	Literature review	N/A
Hylton & Hartman, 1996	Matching medical students' learning needs and their environments to facilitate learning is trend. Moving from traditional to problem-based.	Annotated bibliography	25 studies
Johnson, 1939	No significant relationship between physical skill as measured on Johnson Physical Skill Test and general intelligence as measured by academic performance among college freshmen.	Correlation	310
Kaplan et al., 1990	Right hemisphere damaged patients unable or disinclined to understand mutual knowledge and impute mental states (e.g., intentions) in conversations.	ANOVA	24

(appendix continues)

Appendix A (continued)

Summary of Literature Reviewed

Author(s) & year	Conclusions	Analytic method	N
Khalsa et al., 1988	Educational kinesthetic treatment five days a week for six weeks improved performance on Modified Stork Stand posttest by learning disabled elementary students.	ANOVA	60
Kornhaber et al., 1990	Advocates alternative schooling and assessment methods for America based on Gardner's MI theory; brief comparisons of traditional-agrarian vs. industrial societies and Chinese vs. American contemporary societies.	Literature review	N/A
Li & Gardner, 1993	Differentiates Western and Chinese paintings as two greatly differing domains of which the so-called parameters (pursuit, methodology, symbol systems) place unique constraints on process of creativity.	Case analysis	N/A
Macklem, 1990	Training to improve aptitude must be intensive, involved in task performance, transferable to new areas, provided long-term, fit the tested aptitudes, and use student's other strengths.	Literature review	N/A
McManus & Bryden, 1991	Path model of Geschwind's theory of cerebral lateralization depicts relation to learning disorders, giftedness, and immune deficits. Suggestions are offered for the problems associated with testing such a complex theory.	Literature review	N/A

(appendix continues)

Appendix A (continued)

Summary of Literature Reviewed

Author(s) & year	Conclusions	Analytic method	N
Pinter & Noble, 1920	Use of Stanford-Binet testing to promote 69 students in grades 1-6 one-half to one full grade level. All were "successful" at a higher grade level while working with "coaching" teacher.	Descriptive statistics	69
Rarick et al., 1970	Performance on a youth physical fitness test by educable retarded individuals age 8-18 followed same trend as for normal children with respect to age and gender but all substantially behind standards.	Correlation	4,235
Rehak et al., 1992	Right-hemisphere-damaged patients have difficulty interpreting and judging effects of blocking statements, especially tangential, during conversations.	ANOVA	24
Ross et al., 1997	Testing ability to repeat and comprehend affective prosody under progressively reduced verbal-articulatory conditions supports strong lateralization and dominance of right hemisphere for affective prosody.	MANOVA	22
Schratz & Mehan, 1993	Teacher of fifth grade mathematics uses story of Gulliver's Travels, also being used in German class of same students, for whole-group and cooperative-group interdisciplinary approach. Strategies for applying mathematical reasoning in a meaningful way is emphasized.	Informal observations	36

(appendix continues)

Appendix A (continued)

Summary of Literature Reviewed

Author(s) & year	Conclusions	Analytic method	N
Selkoe, 1992	Cites research indicating older subjects who regularly do aerobic exercise perform better on cognitive tests than do sedentary individuals of the same age with low aerobic fitness.	Literature review	N/A
Sifft & Khalsa, 1991	Educational kinesthetic single treatments improved response time performance on a four-choice, visual stimulus task by college students 19-40 years of age.	ANOVA	60
Travis, 1989	Educational kinesthetic treatment over four-week period had no effect on typewriting speed or accuracy performed by adult volunteers from Employment Training Center in Arlington, Virginia.	ANOVA	75

Appendix B

Tally Sheet for Recording Students' Brain Gym® Participation

Teacher's Signature: _____ Date: _____

WEEK OF _____, 1999	MON.						TUE.						WED.						THU.						FRI.					
Student Name	Brain Buttons	Cross Crawl	Hook-ups	Lazy 8s	Dbl. Doodles	Thinking Cap	Brain Buttons	Cross Crawl	Hook-ups	Lazy 8s	Dbl. Doodles	Thinking Cap	Brain Buttons	Cross Crawl	Hook-ups	Lazy 8s	Dbl. Doodles	Thinking Cap	Brain Buttons	Cross Crawl	Hook-ups	Lazy 8s	Dbl. Doodles	Thinking Cap	Brain Buttons	Cross Crawl	Hook-ups	Lazy 8s	Dbl. Doodles	Thinking Cap
1.																														
2.																														
3.																														
4.																														
5.																														
6.																														
7.																														
8.																														
9.																														
10.																														
11.																														
12.																														
13.																														
14.																														
15.																														
16.																														
17.																														
18.																														
19.																														
20.																														

√ = Child participated χ = Child did not participate

VITA

Sandra Harmon Witcher

Education

Ed.D. in Educational Leadership and Policy Studies
Virginia Polytechnic Institute and State University
Blacksburg,VA
(March 2001)

M.S. in Educational Administration
Old Dominion University
Norfolk, VA
(December 1990)

B.S. in Biology
James Madison University
Harrisonburg, VA
(May 1986)

Employment Experience

Principal (1999-present)
Mt. Zion Elementary School, Suffolk, VA

Assistant Principal (1992-1999)
Booker T. Washington Elementary School, Suffolk, VA
Forest Glen Middle School, Suffolk, VA
Nottoway Middle School, Nottoway, VA

Teacher (1986-1992)
Southampton Middle and High Schools, Southampton, VA
Cumberland High School, Cumberland, VA

Professional Affiliations

Tidewater Association of Supervision and Curriculum
Suffolk Administrative, Leadership, and Supervisory Association
Suffolk Reading Council
Suffolk Education Foundation
Hampton Roads Leadership Education Academy (Class of 2000)