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Reading Fluency and GoNoodle© Brain Breaks Among Elementary-Aged Children

Hannah Jeanne Wold
Brigham Young University

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David Barney, Chair
Keven Prusak
Carol Wilkinson

Department of Teacher Education

Brigham Young University

ABSTRACT

Reading Fluency and GoNoodle© Brain Breaks Among Elementary-Aged Children

Hannah Jeanne Wold
Department of Teacher Education, BYU
Master of Arts

This study examines the immediate and chronic effects of physical activity (PA) breaks on reading fluency. While many teachers recognize the value of PA for increasing engagement and focus (getting the wiggles out) in academic endeavors, these results reveal increases in academic achievement in reading fluency are also possible.

This study examines 384 second and third grade students with low income backgrounds from the Rocky Mountain region. A two-way analysis of variance (ANOVA) was used to examine the effects of chronic and acute brain breaks via GoNoodle© (McQuigg, 2013) on reading fluency and physical activity (steps). Between group differences were further examined using a series of Bonferroni adjusted one-way ANOVAs. A significant acute main effect was evident for (a), and (b) WR ($F(1, 380) = 14.54$, $p < .001$). Also, there was a trend toward a significant acute main effect on WPM ($F(1, 380) = 4.02$, $p = .046$) and chronic effects on WPM (F(1,380 = 3.13, $p = .078$) and accuracy ($F(1, 380) = 4.45$, $p = .036$).

Correlational analysis reveals relationships among selected variables were in the anticipated direction. Analysis reveals significant, positive correlations between free and reduced lunch (FRL) status and reading fluency scores. Moving off free and reduced lunch status is related to small to moderately higher fluency scores: WPM ($r = .34$), accuracy ($r = .14$), WR ($r = .22$), and WIDA ($r = .35$). Dynamic Indicators of Basic Early Literacy Skills (DIBELS) fluency indices show strong positive correlations among themselves and share significant and strongly positive correlations with WIDA scores. Data suggests that higher SES are positively related to higher levels of reading fluency on both the DIBELS and WIDA measures. Also, as anticipated, the DIBELS and WIDA appear to share a strong relationship in measuring reading fluency.

In today's educational landscape of high stakes testing perhaps the value of frequent PA breaks such as GoNoodle© have merit. Reading fluency (WPM, accuracy, and WR) and PA are linked and PA has been found to have a positive impact on the reading culture in the classroom.

Keywords: reading, fluency, physical activity, brain breaks, GoNoodle©

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DESCRIPTION OF THESIS STRUCTURE

This thesis, Reading Fluency and GoNoodle© Brain Breaks Among Elementary-Aged Children, is written in a hybrid format. The hybrid format brings together traditional thesis requirements with journal publication formats. The preliminary pages of the thesis reflect requirements for submission to the university. The thesis report is presented as a journal article and conforms to length and style requirements for submitting research reports to education journals. The appendix includes a review of the literature.

Introduction

An important focus while teaching elementary students is to develop their reading skills. Usually reading instruction is focused on better strategies for teaching literacy. However, there is some evidence that the way in which children are instructed in literacy and the lack of physical activity may create some of these inequalities. This introduction examined how some of the inequalities occurring result from using workbooks and flashcards; influencing the shortfalls in the setting and environment. Then it reports on how No Child Left Behind initiatives, tied with federal funding, have led to more assessment tools being used to measure reading fluency (No Child Left Behind Act, ESEA, 2001).

Finally, this introduction examines physical activity trends in the United States as an alternative strategy that teachers can use to improve reading fluency. Specifically, it explores the Whole School, Whole Community, Whole Child Approach in physical activity, a Comprehensive School Physical Activity Program (CSPAP), and the effects these have in the classroom setting.

Teaching Reading with Workbooks and Flashcards

Typically, when elementary students are in need of intensive intervention, they are drilled with flash cards and worksheets. They actually read fewer words than the more capable readers in their classrooms who are sent off to read independently while their teachers drill small groups of students (Allington, 2012). Allington (2012) posits that proficient readers end up reading thousands more words than the students who spend time with workbooks and flashcards. This causes the achievement gap to grow (Allington, 2012; Neuman & Celano, 2001; Serafini, 2010).

Teaching Reading Within a Limited Setting and Environment

Neuman and Celano (2001) argue that the impact of setting and social structure must not be underestimated when considering children's literacy development. Long before children enter the school system, there are inequalities in print availability, modeling of adults reading, and access to books.

A critical study by Neuman and Celano (2001) found that perceived deficits in individual children might instead be shortfalls in setting and environment. They looked at four neighborhoods in the same city in regard to their print access. Print access was operationally defined as the quality and selection of books available to buy, signage of businesses, and public areas where children might observe adults reading. The researchers plotted on a map each place where books, magazines, and newspapers were sold. Since much regard is given to student choice of reading material, research assistants also counted the number of titles available to purchase in each neighborhood. They also observed patrons in local businesses where people might typically read.

Findings revealed that children from middle class neighborhoods were fully immersed in text, whereas children would have to work hard to find print in low-income communities. A child could choose from thousands of titles in middle-income neighborhoods. Only one title per 300 children was found for sale in the low-income neighborhoods. In middle class neighborhoods, children might observe adults sitting and reading newspapers in public places. There was no reading material available in businesses in low-income neighborhoods. This study suggests that the visibility and value of literacy resources may influence children's literacy development. Further, social outlook toward literacy shapes children's reading lives. Children who enter school at a disadvantage for print access are likely to have lower literacy skills and be put into remedial programs. Such placements widen the reading gap with lower achieving students receiving less exposure to text than their more skilled peers receive (Neuman & Celano, 2001). Reading skills increase when students read more. Children who are skilled at reading (meaning they read with great fluency, accuracy, and comprehend what they are reading) read in larger volume than less skilled readers do. They possess faster phonological processing for letter-sound application and self-testing that provides them with growth in vocabulary and comprehension (McGill-Franzen, Lanford, & Adams, 2002; Clarke, Truelove, Hulme, & Snowling, 2013). Not only do skilled readers read more text, and gain enjoyment from reading, they like to read more than non-skilled readers do (Clarke, Truelove, Hulme, & Snowling, 2013). This is another example of how the child's opportunity and literacy context result in a widening of the achievement gap (Parr, Jesson, & McNaughton, 2009).

The Impact of No Child Left Behind Act (NCLB) on Reading

Reading fluency has been a subject of research and debate for some time. However, it has risen to a much higher level of prominence in classroom instruction and assessment since fluency was incorporated into the Reading First guidelines of No Child Left Behind Act (NCLB) in 2002 (No Child Left Behind Act, ESEA, 2001). Given that Reading First's focus on fluency rests heavily on the findings of the National Reading Panel (NRP; Cunningham, 2001), it is important to note that the NRP *assumes*, but does not *establish,* with scientific evidence, a firm relationship between fluency and comprehension or overall reading proficiency. In fact, the report presents research findings only on studies that examine possible links of various instructional strategies to increased fluency, defined as "the ability to read a text quickly, accurately, and with proper expression" (NRP, 2000, p. 3–5). Nevertheless, Reading First guidelines (An Overview of

Reading First, 2001) pronounce fluency instruction and assessment as essential and stipulate that funding proposals must reflect a major focus on fluency instruction and assessment.

The NRP report suggests a variety of assessment procedures that may be used to index fluency, including: informal reading inventories, miscue analysis, pausing indices, running records, and reading speed calculations (Cummings et al., 2012). Indeed, this instrument index reaches fluency and accuracy but does not address comprehension in spite of an effort by the authors of the NRP to encourage the practice of rating fluency while readers are attending to comprehension, it is still common to see instructional grouping practices based on comparison of students' accurate reading rates to some established grade level benchmark that does not incorporate reading comprehension (Mathson, Allington, & Solis, 2006).

Federal funds granted to states through Reading First must be spent only on those programs deemed to be based on "Scientifically Based Reading Research" and which directly address phonemic awareness, phonics, fluency, vocabulary, and comprehension. One approved program that has been widely adopted as a means of assessing fluency is the Dynamic Indicators of Basic Early Literacy, or DIBELS (Cummings et al., 2012). The battery of subtests within the DIBELS assessment program attends to discrete skills such as phonemic awareness and phonics, as well as to oral reading fluency. The only measure of comprehension in the DIBELS battery is Retelling Fluency (RTF), embedded in the Oral Reading Fluency subtest. The RTF measures comprehension by quantifying the number of words spoken by students in one minute of retelling after completing the oral reading of test passages. This retelling score, which is not subject to any qualitative analysis of content beyond detection of repetitions and off-topic comments, is used only to screen and dismiss an "invalid" oral reading score.

The Dynamic Indicators of Basic Early Literacy Skills (DIBELS) has gained widespread use in the United States as a measure of early reading skills and, coincidentally, is required statewide independent of this study. DIBELS has subtests designed to measure reading skills emphasized in the National Reading Panel report (Cunningham, 2001) including phonemic awareness, phonics, fluency, and, to some degree, comprehension. DIBELS data are collected routinely for many schools as part of ongoing school-improvement efforts in reading.

Physical Activity Trends

Despite public policy and intervention efforts intended to combat the trend (United States Department of Health and Human Services [USDHHS], 2008; Strong et al., 2005) childhood obesity in the United States (US) has nearly tripled (Centers for Disease Control and Prevention [CDC], 2012. Overweight trends and obesity among school aged children remain high (Kahan & McKenzie, 2015; Ogden, Carroll, Kit, & Flegal, 2012). Additionally, children's physical activity (PA) remains well below current guidelines (Erwin, Beighle, Carson, & Castelli, 2013; Troiano et al., 2008) despite the many known health benefits such as reduction of blood pressure, increased energy levels, as well as the psychological benefits of decreased anxiety, decreased depression, and improved self-concept (Erwin et al., 2013; Strong et al., 2005). Additionally, children who regularly engage in physical activity (PA), usually determined by 60 minutes of moderate to vigorous physical activity (MVPA) per day (Donnelly et al., 2009), and are physically fit, are more likely to attend school and have higher levels of academic achievement than their peers who do not (Castelli et al., 2014; Castelli, Hillman, Buck, & Erwin, 2007; Castelli, Hillman, Hirsch, Hirsch, & Drollette, 2011; Chomitz et al., 2009; Kamijo et al., 2014; Rasberry et al., 2011; Welk et al., 2010).

One potential reason for the excessive inactivity and sedentary behavior is public policy. An unintended outcome of systematic accountability initiatives, such as *No Child Left Behind* and *Race to the Top,* was that schools have become environments manifesting sedentary behaviors as an increased allocation of time spent in language arts and mathematics subject matter have led to the reduction of time spent in physical education and recess. Even though such academic pursuits limits PA opportunities, schools remain an ideal place to promote and engage in PA, as most children attend school (Pate et al., 2006). Some schools are beginning to target student PA from a Whole School, Whole Community, Whole Child, (WSCC) perspective (see Figure 1.)

Figure 1. Whole Schools, Whole Community, Whole Child (WSCC) model (Association for Supervision and Curriculum Development, ASCD, 2019)

The Whole School, Whole Community, Whole Child Approach to Physical Activity

The WSCC child-centered model creates the organizational structure for the enhanced, alignment, integration, and collaboration between education and health. The model emphasizes a community approach to health with schools functioning as a key member of that community because a school, as a hub, is a reflection of the community. Within the WSCC model schools may consider a whole-of-school approach (Institute of Medicine, 2013) in order to implement policy and the integration of PA opportunities across the curriculum (e.g., PA breaks in the classroom, recess, moderate to vigorous physical activity offered during physical education).

Since 1987, CDC's coordinated school health (CSH) approach has been the blueprint for integrating health-promoting practices in the school setting. CSH programs have helped to establish policies and practices in states, districts, and schools across the nation, and will see continued success within the expanded (WSCC) model (CDC, 2015).

The WSCC model is an expansion and update of the CSH approach. The WSCC model focuses its attention on the child, emphasizes a school-wide approach, and acknowledges learning, health, and the school as being a part and reflection of the local community (Erwin et al., 2013). The WSCC model has ten specific components (see Figure 1): health education, nutrition environment and services, employee wellness, social and emotional school climate, physical environment, health services, counseling, psychological, and social services, community involvement, family engagement, and physical education and physical activity. By focusing on youth, addressing critical education and health outcomes, organizing collaborative actions and initiatives that support students, and strongly engaging community resources, the WSCC approach offers important opportunities that may improve healthy development and educational attainment for students (Erwin et al., 2013). The Institute of Medicine identifies a

Comprehensive School Physical Activity Program (CSPAP; see Figure 2) as one example of a Whole-of-School approach to target PA opportunities for children throughout the day. Coordinated health models, defined as multiple part programs that involve the use of common messaging and shared resources, have increased their efforts toward increasing physical activity (Erwin et al., 2013).

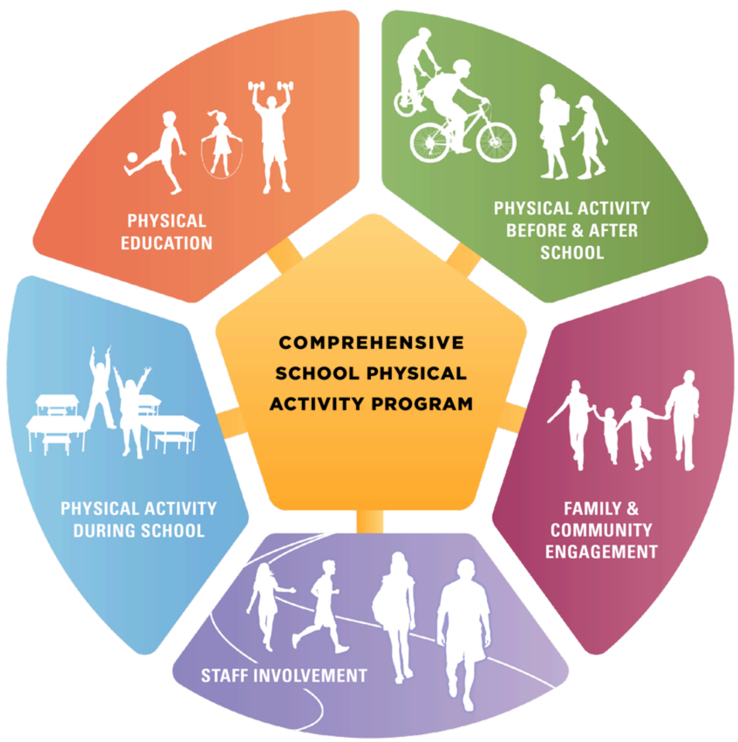

Figure 2. Comprehensive School Physical Activity Program (CSPAP) model (Advanced Solutions International Inc., 2019)

Comprehensive School Physical Activity Programs (CSPAP)

While coordinated approaches to school health are not new (Erwin et al., 2013), insufficient PA has only been acknowledged as a health risk for a short time (Strong et al., 2005). A CSPAP is a whole-of-school multicomponent approach, which derived from the Coordinated School Health (CSH) model. The model calls for faculty, staff, and parents, in a collective effort, to provide services for children to achieve the recommended sixty minutes of physical activity each day (Kelder, Karp, Scruggs, & Brown, 2014). CSPAP involves five components (see Figure 2): staff involvement, physical activity during school, physical education, physical activity before and after school, and family and community engagement. With all components working together, the child can theoretically achieve the recommended sixty minutes of physical activity per day. Each point of intervention has its unique set of facilitators and inhibitors (Kelder et al., 2014) and schools decide which components to focus more or less on based on the needs of the students they serve.

In 2008, Texas mandated that schools adopt a CSH model and ensure that students obtain a minimum of 135 minutes of physical activity per week with a majority of those minutes spent on moderate to vigorous physical activity (Cooper et al., 2010). That same year, National Association for Sport and Physical Education (NASPE) endorsed a physical activity centered approach to school health referred to as a Comprehensive School Physical Activity Program (CSPAP) (Strong et al., 2005).

CSPAP's five components, when implemented correctly, can be effective in increasing student physical activity throughout the school day (Centeio et al., 2014; Goh et al., 2014). Physical educators implementing CSPAP have been reported to increase student physical activity levels (Chen, Hypnar, Mason, & Zalmout, 2014). Several questions remain about the training and preparation needed for physical educators and other faculty members to fully embrace the responsibilities and opportunities of implementing a CSPAP (Kelder et al., 2014). For example, one study found that preservice physical education teachers had difficulties interacting with high school students outside of a traditional physical education class and distinguishing between their roles as a teacher of physical education and a promoter of physical activity. Another challenge facing the program, while CSPAP principles are sound, each school must individually tailor the program to meet student needs (Jones et al., 2014).

It is noteworthy that CSPAP is a framework for the organization of physical activity, but many districts, schools, and individual teachers have been applying principles, in part, for some years. However, relatively few schools actually use all five components of CSPAP (Jones et al., 2014). For example, one study found that students' school physical activity increased significantly when district and school interventions were in place, although results are a little unclear because student physical activity self-assessments were used as the measurement tool (Ernst & Pangrazi, 1999). A follow up study using pedometers looked at elementary schools in Arizona. Their physical activity intervention called *Promoting Lifestyle Activity in Youth* (PLAY) was used as a supplemental physical activity program and did not replace physical education. They observed that the program increased physical activity levels in students and especially for girls (Pangrazi, Beighle, Vehige, & Vack, 2003). The study was enlightening because typically boys have shown higher physical activity levels than females (Troiano et al., 2008).

Unfortunately, there are still challenges to the CSPAP approach being applied in real-world situations. Teacher overload, shortage of resources, teacher buy-in, and administrator buy-in are all still huge barriers for physical activity programs (Jones et al., 2014). For these reasons, further research in physical activity programs has been suggested (Dobbins, Husson, DeCorby, & LaRocca, 2013). Different interventions have been looking to support the idea that health and academics are not mutually exclusive concepts (Ahamed et al., 2007). More research is needed to identify how particular physical activity practices influence student learning.

Physical Activity in the Classroom

Although PA during school can be incorporated in multiple ways (e.g., club activities, PE, and sports; Dobbins et al., 2013), students spend a majority of their school time in classrooms (Donnelly & Lambourne, 2011) thus, within the CSPAP framework, classroom teachers are well situated to provide PA opportunities for their students. Not surprisingly, classroom PA has been shown to account for less than 5% of total daily PA among children (Brusseau et al., 2011), thus underscoring the opportunities for classroom teachers to provide PA during classroom instruction. Given the variability in years of teaching experience, where and how teachers received teacher certification, and what professional development opportunities have been currently offered to teachers, teachers may need further training to provide optimal PA opportunities in the classroom setting. Classroom PA can follow pre-established curriculum (e.g., GoNoodle©; McQuigg, 2013; TAKE 10!®; Stewart, Dennison, Kohl, & Doyle, 2004), be implemented as part of a teacher's routine (Donnelly & Lambourne, 2011), or occur naturally in the context of a transition between tasks (e.g., mathematics small group work to vocabulary word wall) or locations (e.g., having students do movement while waiting in line to walk to the lunchroom) across the day.

There is emerging research suggesting that when a PA program is introduced into the classroom setting or used during academic lessons, the overall rate of engagement within that given classroom increases (Erwin, Beighle, Morgan, & Noland, 2011; Phillips, Hannon, & Castelli, 2014). Further, in classrooms where a teacher models and participates in PA, the students, especially girls, have higher PA than in a classroom where teachers do not demonstrate this behavior (Ernst & Pangrazi, 1999). In addition, it has been observed that children are more likely to demonstrate on-task behavior during academic tasks following classroom PA breaks

(Grieco, Jowers, & Bartholomew, 2009; Mahar et al., 2006). PA is the ultimate link needed for improving reading fluency, accuracy, and comprehension in the classroom and closing the widening achievement gap.

GoNoodle© as Classroom Physical Activity

Though teachers may utilize several methods and media to offer students opportunities with PA in the classroom setting, of particular interest in this study is an online program called GoNoodle©, which is a web-based resource containing developmentally appropriate interactive games and videos that are designed to encourage students to participate in PA. Today, GoNoodle© has over 2 million children, in 180 countries in schools and in their home, as the website is accessible at any time or place where there is Internet access. Specifically, GoNoodle© is designed to assist classroom teachers in engaging elementary (K-5) children in short bouts of physical activity/brain breaks throughout the school day with the dual purpose of incrementally increasing student PA and resetting attention for academic tasks. A teacher uses a projection system to display a GoNoodle© modular activity on the screen for the entire class to follow in unison or create spaces where children can engage in PA in small or large groups. GoNoodle© sponsors activities that vary in type, intensity, and duration. Modules are broken down into seven categories: (a) guided dancing, (b) free movement, (c) stretching, (d) sports and (e) exercise, (f) kinesthetic learning, (g) coordination, and (h) calming. Although some modules are of a calming nature, for simplicity, this thesis will use the phrase *PA breaks* in describing all GoNoodle© modular activities.

Some important activities include dance, exercise routines, and flexibility routines, thus representing a summative volume of physical activity that is based on frequency, intensity, and type of activity. PA is designed to be incentivized and reinforced through the selection of a virtual class mascot called a Champ. As students in each class accumulate the prescribed amount of usage for a given level, the mascot grows. An additional feature is that children have access to GoNoodle© activities from home. However, little is known about the effectiveness of implementing classroom PA breaks via GoNoodle© on academic achievement (Whitney, 2016). Furthermore, the efficacy and feasibility of the GoNoodle© program has yet to be externally evaluated.

Purpose of the Study

Most research that focuses on the development of reading fluency focuses on instructional strategies. In contrast, this study focuses on whether PA will actually affect reading fluency. With the limited amount of research on classroom physical activity, little is known about how classroom PA breaks affect student reading fluency and virtually nothing is known about the specific GoNoodle© facilitated classroom breaks (Whitney, 2016). Understanding how GoNoodle© affects reading fluency within the DIBELS reading assessment will help educators determine the benefits of devoting more time to brain breaks like GoNoodle© in the classroom setting. By increasing the amount of time spent doing PA in the classroom, teachers may be able to accomplish two goals, namely: (a) increase reading fluency in primary grades and (b) adhere to the CSPAP framework calling for an increase of PA within different daily tasks. Therefore, the purpose of this thesis study is to assess the immediate and chronic effects of physical activity breaks on reading fluency.

We hypothesize that increasing physical activity in the classroom will increase reading fluency within WPM, accuracy, and WR. We also hypothesize that chronic amounts of physical activity may have the best fluency results and acute bouts of physical activity will also positively impact fluency.

Method

Participants and Setting

This study took place at four public Title One elementary schools, grades second and third, 16 classes total, in a state in the Intermountain west. This study received approval from the University's Internal Review Board (IRB) as well as the school district's IRB.

All participants (*n* =384, 208 males and 176 females) were informed of all study procedures and of their right to stop participating in this study at any time without incurring negative consequences. Those students who did not volunteer to participate were still invited to join the brain break activity as if it were a normal school day and were still given their end of school year DIBELS reading assessment. Of the sixteen classes that were included in the study, eight consisted of entirely second-grade students and eight consisted of entirely third-grade students ($r_{class\ size}$ = 20-30). School demographics are reported as 70% White, 28% Hispanic, and 2% other ethnicities (Asian, Black, Indian, Pacific Islander). Fifty percent of students at the schools are currently receiving free or reduced lunch at all Title One schools.

All classrooms are configured with individual student desks arranged in rows, groups of four, or as partners including a large carpeted space sufficient to accomplish daily physical activity breaks.

Research Design

Sixteen (eight second and eight third grade) intact classes were each assigned to one of four distinct treatment groups (see Figure 1) referred to throughout paper in a 2 (levels of chronic use of brain breaks) by 2 (levels of acute use of brain breaks) in a quasi-experimental, factorial design. Each group is represented by two second- and two third-grade classes. Dependent variables of interest include reading fluency and steps-per-minute pedometry scores). This design allows for the comparison of those with/without chronic use of physical activity (PA) breaks across those with/without an acute bout of physical activity immediately before assessing reading fluency and PA rates. Of primacy in this study are both the chronic and acute effects of GoNoodle© brain breaks on reading fluency.

	Treatment Group: Acute use of brain break Participated in a brain break activity just prior to taking the DIBELS assessment	**Control Group: No acute use of brain break** Did not participate in a brain break activity the day they took the DIBELS assessment
Chronic history of brain breaks Had been doing brain breaks activities all year long (History of brain break/GoNoodle© use)	**Group A** Two second grade classes and two third grade classes	**Group B** Two second grade classes and two third grade classes
No chronic history of brain breaks Does not do brain break/GoNoodle© activities in the classroom regularly	**Group C** Two second grade classes and two third grade classes	**Group D** Two second grade classes and two third grade classes

Figure 3. Factorial design depicting two levels of chronic brain breaks by two levels of acute brain breaks.

Instruments

Dynamic Indicators of Basic Early Literacy Skills (DIBELS). The Dynamic Indicators of Basic Early Literacy Skills (DIBELS) has gained widespread use in the United States as a measure of early reading skills and, coincidentally, is required statewide independent of this study. DIBELS has subtests designed to measure reading skills emphasized in the National Reading Panel report (Cunningham, 2001) including phonemic awareness, phonics, fluency, and, to some degree, comprehension. DIBELS data are collected routinely for many schools as part of ongoing school-improvement efforts in reading. DIBELS assessment has been found to be both reliable and valid (Martin & Shapiro, 2011) to assess the three theories of reading fluency (information-processing theory: words per minute [WPM], connectionist theory: accuracy, and rauding theory: words retold [WR]).

The creators of DIBELS assert that its subtests pertinent to this study (WPM, accuracy, and WR) are useful for predicting future reading difficulty and facilitating early and accurate identification of students in need of intervention (Cummings, 2012).

The DIBELS measures are relatively fast—typically take 1-3 minutes per student to administer—and are efficient indicators of critical early literacy assessments. DIBELS can help identify and remediate students who may need additional instruction to meet benchmark reading goals. DIBELS assessment materials are available for download (Serafini, 2010), free for educational use.

District level reading fluency test proctors administer DIBELS three times yearly (beginning, middle and end of year) in order to identify students who may be at risk for reading difficulties. DIBELS helps identify children who are "on track" for learning to read, monitor at-risk students, and identify students who may need additional instructional support to meet reading goals. DIBELS are used only to help children learn to read, not used to grade children or to make decisions about retention. Further, DIBELS is used as a formative assessment as students receive additional, targeted instruction. Finally, principals in this district use DIBELS to examine the overall effectiveness of the instructional supports provided to classroom teachers within this school.

According to its authors, DIBELS is a valid indicator of reading fluency, and can be used to "(a) identify children who may need additional support, and (b) monitor progress toward instructional goals" (Cummings et al., 2012, p. 30). The DIBELS manual offers the following scientific justification for its assessment of oral reading fluency: DIBELS Oral Reading Fluency (DORF) is a standardized, individually administered test of accuracy and fluency with connected text.

World-Class Instructional Design and Assessment (WIDA). World-Class Instructional Design and Assessment (WIDA) is a language proficiency test for English as second language (ESL) students designed to assess ability to read in English (Language, Assessment, and English Language Learners, 2016). The WIDA is required statewide for all ESL students on a yearly basis. WIDA scores are used to assess ESL student needs for intervention. Lack of proficiency represents a possible confounding variable to reading fluency scores and were examined as a possible covariate. The WIDA English Language Proficiency (ELP) Standards have been adopted by 26 states at the time of writing since the passage of NCLB. The WIDA 2nd edition, published in 2007, is an updated version of the initial 2004 WIDA standards that were developed with an Enhanced Assessment Grant to the original consortium states (Wisconsin, Delaware, and Arkansas) from the US Department of Education, with provision of funding from NCLB. Moreover, the WIDA ELP Standards, 2004 edition, were augmented by Teaching English to

Speakers of Other Languages (TESOL) in 2006 to replace their initial standards published in 1997. The developers view the standards as a ‘critical tool for educators of ELLs for curriculum development, instruction and assessment. A stated major purpose of the WIDA ELP Standards is to serve as a blueprint for the Assessing Comprehension and Communication in English State to State for English Language Learners (ACCESS for ELLs®) assessment that states use for accountability under NCLB (Bailey & Huang, 2011).

Pedometry. Pedometer readings, recorded as steps, served as a measure of physical activity during GoNoodle© physical activity breaks. Yamax, Digi-Walker, model LS2525 (a valid instrument for recoding ambulatory movements for similar populations; Barfield, Rowe, & Michael, 2004; Easton, Rowland, & Ingledew, 1998; Scruggs et al., 2003) was used to record steps during the GoNoodle© activity breaks. Recording physical activity (steps) was primarily done to assess any confounding effects of differing levels of physical activity between groups.

Procedure

Classroom teachers and district DIBELS test personnel attended at training meeting in advance of this study to learn all procedures. Classroom teachers were trained on how to collect physical activity data (step counts via pedometers) and, in turn, teachers trained their students on pedometer use. District DIBELS proctors followed standard district testing procedures in each of three test periods across the school year.

Classes in groups A and B followed a free, online GoNoodle© exercise program providing daily, 10-12-minute activity breaks across the school year. Classes in groups C and D participating in the study did not participate in the GoNoodle© exercise program or any other form of classroom activity breaks. Thus, groups A and B are considered to have a “chronic” history of brain break use in the classroom. Groups C and D are the control group for having no chronic use of GoNoodle©.

Prior to data collection day, students were taught how to use the pedometers, record their steps, and submit them to the teacher who entered scores into the database. On the final DIBELS assessment day, classes in groups A and C experienced an acute episode of GoNoodle© participated in a routine lasting 10-12 minutes during which time, pedometers recorded student physical activity. Since Groups B and D did not participate in a GoNoodle© routine on the final DIBELS test day, neither were given pedometers nor did they have to collect physical activity data.

All four groups received district trained DIBELS reading fluency testing in the schools' media centers. Twenty-six, certified district level DIBELS testers simultaneously administered the fluency to all students, with Groups A and C assessment conducted immediately after participating in the GoNoodle© physical activity break.

The DIBELS reading fluency assessment consists of the daily oral reading fluency (DORF) portion of the test. Students read 3 passages for one minute each, stopping when prompted. Proctors calculate and record an average WPM, accuracy, and WR score for each student.

Student data such as gender, free and reduced lunch status (to determine socio-economic status; SES), and World Class Instructional Design and Assessment (WIDA) data was collected to rule out other performance altering factors.

Data Analysis

IBM Corp. SPSS, Statistical Package (version 25; 2017) was used for all statistical analyses. Descriptive statistics (means, standard deviations, and Eta^2) were calculated for all response variables. Correlation analysis was conducted to examine the association between group membership, steps, and reading fluency, WIDA scores and, physical activity.

A two-way analysis of variance (ANOVA) was used to examine the effects of chronic and acute brain breaks via GoNoodle© on reading fluency and physical activity (steps). Between group differences were further examined using a series of Bonferroni adjusted one-way ANOVAs.

Limitations

Limitations of this study is the quasi-experimental design method since only students with intact classes were measured. Using only second and third grade students for this study will only let us know how this age range responds to reading fluency after an exercise program. This study also is only looking at the effects of one specific exercise program *GoNoodle©* and how that affects reading fluency. Future studies may want to examine other exercise programs and other ages of students.

Results

Descriptive and Comparison Statistics

Means and standard deviations listed for main and simple effects are located in Table 1 for WPM, accuracy and WR. No SES, gender, step counts or WIDA effects were noted. A significant acute main effect was evident for (a) accuracy ($F(1, 380) = 7.20$, $p = .008$), and (b) WR ($F(1, 380) = 14.54$, $p < .001$). Also, there was a trend toward a significant acute main effect on WPM ($F(1, 380) = 4.02$, $p = .046$) and chronic effects on WPM ($F(1,380 = 3.13$, $p = .078$) and accuracy ($F(1, 380) = 4.45$, $p = .036$). Thus, it appears that acute bouts of physical activity have a significant and positive effect on measures of accuracy and words retold. Trending towards significance were acute effects on WPM, chronic effects of cumulative bouts of physical activity on WPM and accuracy.

Computed Eta^2 reveal small effect sizes (r_{Eta2} = .000 - .04) for acute and chronic main effects. Specifically, Eta^2 for WPM_{acute} = .01 and $WPM_{chronic}$ = .008; $accuracy_{acute}$ = .019 and WR_{acute} = .037 and $WR_{chronic}$ = .000.

Correlation Analysis

Correlational analysis revealed relationships among selected variables were in the anticipated direction. Analysis revealed significant, positive correlations between free and reduced lunch (FRL) status and reading fluency scores (see Table 2). Students not on free and reduced lunch status were related to small to moderately higher fluency scores: WPM (r = .34), accuracy (r = .14), WR (r = .22), and WIDA (r = .35). DIBELS fluency indices show strong positive correlations among themselves and share significant and strongly positive correlations with WIDA scores (see Table 2). Data suggests that higher SES is positively related to higher levels of reading fluency on both the DIBELS and WIDA measures. Also, as anticipated, the DIBELS and WIDA appear to share a strong relationship in measuring reading fluency.

Table 1

Means and Standard Deviations Across Words Per Minute, Accuracy, and Words Retold

Acute use of Brain Breaks	Chronic use of Brain Breaks	Group	N	Words per Minute		Accuracy		Words Retold	
				M	SD	M	SD	M	SD
Acute	Chronic	A	96	92.63	30.78	3.15	.99	37.42	19.19
	Non-Chronic	C	72	87.96	32.19	3.04	1.03	36.61	19.64
	Total		168	90.63	31.38	3.10**	1.00	37.07***	19.33
No Acute	Chronic	B	96	87.20	32.14	2.98	1.05	29.39	16.71
	Non-Chronic	D	120	80.51	30.25	2.63	1.10	30.03	18.52
	Total		216	83.48	30.76	2.78	1.09	29.74	17.70

Note. ** = $p < .01$, *** $p < 001$, Bonferroni adjusted $p = .017$

Table 2

Pearson Correlations

	FRL	WPM	Accuracy	WR	WIDA
FRL		.34**	.14**	.22**	.35**
WPM			.52**	.67**	.87**
Accuracy				.50**	.60**
WR					.81**
WIDA					

Note. ** = $p <.01$

Discussion

This study examined the immediate and chronic effects of physical activity breaks on reading fluency. While many teachers recognize the value of PA for increasing engagement and focus ("getting the wiggles out") in academic endeavors (Barney & Deutsch, 2009), these results indicate that increases in academic achievement in reading fluency are also possible. It is important to note that fluency is not an end in itself but a critical gateway to comprehension. Fluent reading frees resources to process meaning. In order to become fluent students must perform the task or demonstrate the skill accurately, and perform the pre-skills of the task quickly and effortlessly. Once accuracy is achieved fluency develops through plentiful opportunities for practice in which the task can be performed with a high rate of success (Wolf & Katzir-Cohen, 2001). This study looked at fluency success through the lens of physical activity on meeting these needs.

Short-Term or Acute Effects of Physical Activity Breaks in the Classroom

Notably, the most pronounced effects were immediately following acute bouts of PA on reading fluency measures. Therefore, teachers and parents may reconsider physical activity breaks as more than a means to "get the wiggles out." There appears to be more of a cognitive benefit than they may have previously recognized. Indeed, this study seems to support recent research connecting physical activity to other brain functions such as cognition, focus, and so on.

Studies have shown that a single bout of exercise, such as 30 minutes of cycling or running, can improve automatic aspects of cognition such as reaction time and speed of information processing (Ratey & Loher, 2011). Acute exercise also improves performance on higher-order cognitive processes, including executive cognitive tasks such as planning, scheduling, inhibition, and working memory (Wolf & Katzir-Cohen, 2001). Evidence suggests that physical activity beneficially influences brain function and executive cognitive processes in particular. Additional insights from future studies will continue to clarify the beneficial effects of physical activity (Ratey & Loehr, 2011). Considering the small effect sizes, these results should be given an appropriate level of caution.

Long-Term or Chronic Effects of Physical Activity Breaks in the Classroom

Trending towards significance are acute main effects on WPM and chronic main effects on WPM: ($F(1,380)=3.13$, p =.078) and accuracy ($F(1,380)=4.45$, $p=.036$). In such cases, we are reminded of the article “Surely God Loves the .06 Nearly as Much as the .05” (Rosnow & Rosenthal, 1989) and believe that one should not discount the possibility of Chronic PA effects on long-term reading fluency. Further research is needed to investigate these trends of chronic effects.

It is interesting that the acute effects on reading fluency were much more pronounced than were the long-term effects. This study seems to suggest that short-term, acute effects require a good deal of consistency before long-term, chronic benefits are realized.

This study is limited in its scope due to the quasi-experimental design of intact classes being used. This study used pedometers to account for student’s physical activity to be rated as moderate to vigorous enough for the use of this study. Heart rate monitors and more sophisticated technology in the future would add to the merit of future studies in looking at the intensity of such physical fitness. Having more data points for chronic using physical activity students and before and after data points would also add to the depth of this study.

Overall, this study accomplished what it was set out to do. It investigated the chronic effects and acute effects and found acute to be more telling about a child’s reading fluency. It looked at three aspects of reading fluency namely WPM, accuracy, and WR. It is the first of its kind to link physical activity to reading fluency unlike other studies that focus on time on task behaviors (Mahar et al., 2006) and math fluency (Rasberry et al., 2011).

In the future, larger scale research focusing on chronic effects of reading fluency is warranted. This study also examined second and third grade students. Future research is needed to examine the effects of physical activity on a larger age range of students. Whether similar results for high-school-aged and beyond populations are in question. However, research by Ratey and Loehr (2011) looks promising and the effects on reading among adult populations warrants future study.

Conclusion

In conclusion, PA in the classroom has both positive acute and trending towards positive chronic effects on reading fluency (WPM, accuracy, and WR). This study examined 384 second and third grade students with low income backgrounds from the Rocky Mountain region. It investigated students who were chronically using PA programs in the classroom (GoNoodle©) and the long-term effects it had on reading fluency. Findings showed data trending towards statistical significance. The study also examined acute effects of physical activity and found there to be statistical significance. Caution should be used however, because the effect sizes were small. This study is the first of its kind to link PA to reading fluency unlike other studies that focus on time on task behaviors (Mahar et al., 2006) and math fluency (Rasberry et al., 2011).

In today's educational landscape of high stakes testing perhaps the value of frequent PA breaks such as GoNoodle© have merit. Teachers can take this research to principals, parents, and other stakeholders and use evidence-based research to justify the time needed for physical activity in the classroom setting. No longer do teachers need to fear reprimand for spending time doing PA in the classroom as opposed to book work. The two are linked and PA has been found to have a positive impact on the reading culture in the classroom.

References

Advanced Solutions International, Inc. (2019). What is CSPAP? Retrieved from https://www.shapeamerica.org/cspap/what.aspx

Ahamed, Y., Macdonald, H., Reed, K., Naylor, P.-J., Liu-Ambrose, T., & Mckay, H. (2007). School-based physical activity does not compromise children's academic performance. *Medicine and Science in Sports and Exercise*, *39*(2), 371-373.

Allington, D. (2012). Private experience, textual analysis, and institutional authority: The discursive practice of critical interpretation and its enactment in literary training. *Language and Literature, 21*(2), 211-225. doi:10.1177/0963947011435864

An Overview of Reading First. (2001). Retrieved from https://www.scholastic.com/teachers/articles/teaching-content/overview-reading-first/

Association for Supervision and Curriculum Development (2019). Whole School, Whole Community, Whole Child. Retrieved from http://www.ascd.org/programs/learning-and-health/wscc-model.aspx

Bailey, A. L., & Huang, B. H. (2011). Do current English language development/proficiency standards reflect the English needed for success in school? *Language Testing, 28*(3), 343-365. doi:10.1177/0265532211404187

Barfield, J. P., Rowe, D. A., & Michael T. J. (2004). Inter-instrument consistency of the Yamax Digi-Walker pedometer in elementary school-aged children. *Measurement in Physical Education and Exercise Science, 8*(2), 109-116.

Barney, D., & Deutsch, J. (2009). Elementary classroom teacher attitudes and perspectives of elementary physical education. *The Physical Educator, 66*(3), 114-123.

Brusseau, T. A., Kulinna, P. H., Tudor-Locke, C., Ferry, M., Van Der Mars, H., & Darst, P. W. (2011). Pedometer-determined segmented physical activity patterns of fourth- and fifth-grade children. *Journal of Physical Activity and Health*, *8*(2).

Castelli, D. M., Centeio, E. E., Hwang, J., Barcelona, J. M., Glowacki, E. M., Calvert, H. G., & Nicksic, H. M. (2014). The history of physical activity and academic performance research: Informing the future. *Monographs of the Society for Research in Child Development*, *79*(4), 119–148.

Castelli, D. M., Hillman, C. H., Buck, S. M., Erwin, H. E. (2007). Physical fitness and academic achievement in third- and fifth-grade students. *Journal of Sport and Exercise Psychology*, *29*(2).

Castelli, D. M., Hillman, C. H., Hirsch, J., Hirsch, A., & Drollette, E. (2011). FIT Kids: Time in target heart zone and cognitive performance. *Preventive Medicine*, *5*(2), S55–S59.

Centers for Disease Control and Prevention. (2012). Retrieved from https://www.cdc.gov/

Centers for Disease Control and Prevention. (2015). Retrieved from https://www.cdc.gov/

Centeio, E. E., McCaughtry, N., Gutuskey, L., Somers, C. L., Shen, B., Martin, J., & Kulik, N. (2014). Physical activity change through comprehensive school physical activity programs in urban elementary schools. *Journal of Teaching in Physical Education*, *33*(4), 573–591.

Chen, W., Hypnar, A. J., Mason, S. A., & Zalmout, S. (2014). Students' daily physical activity behaviors: The role of quality physical education in a comprehensive school physical activity program. *Journal of Teaching in Physical Education*, *33*(4), 592–610.

Chomitz, V. R., Slining, M. M., McGowan, R. J., Mitchell, S. E., Dawson, G. F., & Hacker, K. A. (2009). Is there a relationship between physical fitness and academic achievement?

Positive results from public school children in the northeastern United States. *Journal of School Health*, *79*(1), 30–37.

Clarke, P. J., Truelove, E., Hulme, C., & Snowling, M. J. (2013). *Developing reading comprehension*. Chichester: Wiley-Blackwell.

Cooper, K. H., Everett, D., Meredith, M. D., Kloster, J., Rathbone, M., & Read, K. (2010). Preface: Texas statewide assessment of youth fitness. *Research Quarterly for Exercise and Sport*, *81*(sup3), ii–iv.

Cummings, K. D., Park, Y., & Schaper, H. A. (2012). Form Effects on DIBELS Next Oral Reading Fluency Progress- Monitoring Passages. *Assessment for Effective Intervention, 38*(2), 91-104. doi:10.1177/1534508412447010

Cunningham, J. W. (2001). The National Reading Panel report. *Reading Research Quarterly, 36*(3), 326-335. doi:10.1598/rrq.36.3.5

Dobbins, M., Husson, H., DeCorby, K., & LaRocca, R. L. (2013). School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database Systematic Reviews*, *2*(2).

Donnelly, J. E., Greene, J. L., Gibson, C. A., Smith, B. K., Washburn, R. A., Sullivan, D. K., . . . Williams, S. L. (2009). Physical activity across the curriculum (PAAC): A randomized controlled trial to promote physical activity and diminish overweight and obesity in elementary school children. *Preventive Medicine*, *49*(4), 336–341.

Donnelly, J. E., & Lambourne, K. (2011). Classroom-based physical activity, cognition, and academic achievement. *Preventive Medicine*, *52* (3), S36–S42.

Ernst, M. P., & Pangrazi, R. P. (1999). Effects of a physical activity program on children's activity levels and attraction to physical activity. *Pediatric Exercise Science*, *11*(4), 393–405.

Erwin, H., Beighle, A., Carson, R. L., & Castelli, D. M. (2013). Comprehensive school-based physical activity promotion: A review. *Quest*, *65*(4), 412–428.

Erwin, H., Beighle, A., Morgan, C. F., & Noland, M. (2011). Effect of a low-cost, teacher-directed classroom intervention on elementary students' physical activity. *Journal of School Health*, *81*(8), 455–461.

Easton, R. G., Rowlands, A. V., & Ingledew, D. K. (1998). Validity of heart rate, pedometry, and accelerometry for predicting the energy cost of children's activities. *Journal of Applied Physiology, 84*(1), 364-371.

Goh, T. L., Hannon, J. C., Brusseau, T. A., Webster, C., Podlog, L., & Newton, M. (2014). Effects of a classroom based physical activity program on children's physical activity levels. *Journal of Teaching in Physical Education*, *33*(4), 558–572.

Grieco, L. A., Jowers, E. M., & Bartholomew, J. B. (2009). Physically active academic lessons and time on task: The moderating effect of body mass index. *Medicine and Science in Sports and Exercise, 41*(10), 1921–1926.

IBM Corp. (2017). IBM SPSS (Version 25) [Computer software].

Institute of Medicine. (2013). *Educating the student body: Taking physical activity and physical education to school.* Washington, DC: National Academies Press.

Jones, E. M., Taliaferro, A. R., Elliott, E. M., Bulger, S., Kristjansson, A. L., Neal, W., . . . Allar, I. (2014). Feasibility study of comprehensive school physical activity programs in

Appalachian communities: The McDowell CHOICES project. *Journal of Teaching in Physical Education*, *33*(4), 467–491.

Kahan, D., & McKenzie, T. L. (2015). The potential and reality of physical education in controlling overweight and obesity. *American Journal of Public Health*, *105*(4), 653–659.

Kamijo, K., Pontifex, M. B., Khan, N. A., Raine, L. B., Scudder, M. R., Drollette, E. S., . . . Hillman, C. H. (2014). The negative association of childhood obesity to cognitive control of action monitoring. *Cerebral Cortex*, *24*(3), 654–662.

Kelder, S. H., Karp, G. G., Scruggs, P. W., & Brown, H. (2014). Setting the stage: Coordinated approaches to school health and physical education. *Journal of Teaching in Physical Education*, *33*(4), 440–448.

Language, assessment, and English language learners. (2016). *Assessing English Language Learners,* 23-36. doi:10.4324/9780203521953-3

Mahar, M. T., Murphy, S. K., Rowe, D. A., Golden, J., Shields, A. T., & Raedeke, T. D. (2006). Effects of a classroom-based program on physical activity and on-task behavior. *Medicine and Science in Sports and Exercise*, *38*(12), 20-86.

Martin, S. D., & Shapiro, E. S. (2011). Examining the accuracy of teachers' judgments of DIBELS performance. *Psychology in the Schools,48*(4), 343-356. doi:10.1002/pits.20558

Mathson, R. L., Allington, E., & Solis, R. (2006). If they don't read much, how they ever gonna get good? *Journal of Adolescent & Adult Literacy, 21*(1), 57-61. doi:10.1598/jaal.21.1.10

McGill-Franzen, A., Lanford, C., & Adams, E. (2002). Learning to be literate: A comparison of five urban early childhood programs. *Journal of Educational Psychology, 94*(3), 443-464. doi:10.1037/0022-0663.94.3.443

McQuigg, S. (2013). GoNoodle App. Retrieved from https://app.gonoodle.com/.

Neuman, S. B., & Celano, D. (2001). Access to print in low-income and middle-income communities: An ecological study of four neighborhoods. *Reading Research Quarterly, 36*(1), 8-26. doi:10.1598/rrq.36.1.1

No Child Left Behind Act of 2001, ESEA, 2001, Title 1, Part B, Subpart 1. Southwest Educational Development Laboratory. Summary Report: Awards. Retrieved April 20, 2007 from http://www.sedl.org/readingfirst/report-awards.html

Ogden, C. L., Carroll, M. D., Kit, B. K., & Flegal, K. M. (2012). Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2010. *Jama*, *307*(5), 483–490.

Pangrazi, R. P., Beighle, A., Vehige, T., & Vack, C. (2003). Impact of promoting lifestyle activity for youth (PLAY) on children's physical activity. *Journal of School Health*, *73*(8), 317–321.

Parr, J., Jesson, R., Mcnaughton, S. (2009). Agency and platform: The relationships between talk and writing. In R. Beard, D. Myhill, & M. Mystrand, *The SAGE handbook of writing development* (pp. 246-259). doi:10.4135/9780857021069.n17

Pate, R. R., Davis, M. G., Robinson, T. N., Stone, E. J., McKenzie, T. L., & Young, J. C. (2006). Promoting physical activity in children and youth a leadership role for schools: A scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism (Physical Activity Committee) in collaboration with the councils on Cardiovascular Disease in the Young and Cardiovascular Nursing. *Circulation*, *114*(11), 1214–1224.

Phillips, D. S., Hannon, J. C., & Castelli, D. (2014). The effect of vigorous-intensity physical activity on children's cognition. *Research Quarterly for Exercise and Sport*, *85*(S1), 152-159.

Rasberry, C. N., Lee, S. M., Robin, L., Laris, B. A., Russell, L. A., Coyle, K. K., & Nihiser, A. J. (2011). The association between school-based physical activity, including physical education, and academic performance: A systematic review of the literature. *Preventive Medicine, 5*(2), S10-S20.

Ratey, J. J., & Loehr, J. E. (2011). The positive impact of physical activity on cognition during adulthood: A review of underlying mechanisms, evidence and recommendations. *Reviews in the Neurosciences, 22*(2). doi:10.1515/rns.2011.017

Rosnow, R. L., & Rosenthal, R. (1989). Definition and interpretation of interaction effects. *Psychological Bulletin, 105*(1), 143-146. doi:10.1037//0033-2909.105.1.143

Scruggs, P. W., Beveridge, S. K., Eisenman, P. A., Watson, D. L., Schultz, B. B., & Ransdell, L. A. (2003). Qualifying physical activity via pedometry in elementary physical education. *Medicine & Science in Sports & Exercise, 35*(7), 1065-1071.

Serafini, F. (2010). *Classroom reading assessment: More efficient ways to view and evaluate your readers.* Portsmouth, NH: Heinemann.

Stewart, J. A., Dennison, D. A., Kohl, H. W., & Doyle, J. A. (2004). Exercise level and energy expenditure in the TAKE 10!® in-class physical activity program. *Journal of School Health*, *74*(10), 397–400.

Strong, W. B., Malina, R. M., Blimkie, C. J., Daniels, S. R., Dishman, R. K., Gutin, B., . . . Trudeau, F. (2005). Evidence based physical activity for school-age youth. *The Journal of Pediatrics*, *146*(6), 732–737.

Troiano, R. P., Berrigan, D., Dodd, K. W., Masse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Medicine and Science in Sports and Exercise*, *40*(1), 181.

United States Department of Health and Human Services. (2008). *Physical activity guidelines for Americans.* Washington, DC: author.

Welk, G. J., Jackson, A. W., Morrow, J. R., Jr., Haskell, W. H., Meredith, M. D., & Cooper, K. H. (2010). The association of health-related fitness with indicators of academic performance in Texas schools. *Research Quarterly for Exercise and Sport*, *81*(sup3), S16–S23.

Whitney, E. A. (2016). Using GoNoodle© to Introduce Health Concepts in the K–5 Classroom. *Strategies, 29*(4), 44-48. doi:10.1080/08924562.2016.1182368

Wolf, M., & Katzir-Cohen, T. (2001). Reading fluency and its intervention. *Scientific Studies of Reading, 5*(3), 211-239. doi:10.1207/s1532799xssr0503_2

APPENDIX

Review of the Literature

Reading Fluency

Fluency is a key skill for effective reading. When readers struggle with reading fluency, comprehension and motivation to read can be negatively impacted (Hasbrouck, Ihnot, & Rogers, 1999). Because of the negative effects of disfluent reading, fluency deserves extensive attention (Rasinski, 2012). In the past a general definition of reading fluency was the ability to read quickly and automatically (Logan, 1997). However, today the definition is broadened beyond word calling or just stating the words, to include comprehension as an essential part of fluency (Nathan & Stanovich, 1991). The National Reading Panel (NRP; Cunningham, 2001) defines fluency as the ability to read automatically with proper accuracy, speed, and expression (commonly called prosody), thus freeing the reader's cognitive abilities so meaning of the text can be made. Likewise, Nathan and Stanovich (1991) state that fluency is the ability to rapidly recognize words while speaking with correct prosody, thus allocating the attention toward cognitive processing. Zutell and Rasinski (1991) define fluency as proficient oral reading that includes reading that is effortless or automatic, correct phrasing, and the use of pitch, stress, and intonation.

Three Theories of Fluency

Unlike the other researchers, Zutell and Rasinski (1991) do not include word recognition and comprehension in their definition. They do this for the purpose of focusing educators' attention "on the extent to which reading 'sounds' like speaking, that is, how much it conforms to the rhythms, cadences, and flow of oral language" (p. 212). Due to the many different definitions of reading fluency, Wolf and Katzir-Cohen (2001) conducted a literature review and reported that researchers generally view fluency through one of three theories: (1) the informational-processing theory, (2) the connectionist theory, and (3) the rauding theory.

The informational-processing theory proposes that fluency is acquired through automaticity. This means that a reader receives visual stimuli, such as the letters in a word, and with practice and exposure, the features (letters) in the stimuli become a unit. "As these units accumulate and letter perception becomes increasingly automatic, attention to early visual coding process decreases" (Wolf & Katzir-Cohen, 2001, p. 214). Once the units are automatic, a reader can rapidly retrieve them and therefore read fluently. In contrast to the informational-process theory, the connectionist theory emphasizes "continuous, distributed interaction of phonological, orthographic, syntactic, and semantic processing codes during word recognition" (Wolf & Katzir-Cohen, 2001, p. 217).

Unlike the informational-processing theory, the connectionist theory does not view retrieval mechanisms as the source for coding but acknowledges the importance of other linguistic features, such as prosody. Prosody, or intonation and inflection used by readers, is one of the key links to becoming a fluent reader, yet it has become the "unattended bedfellow," in that researchers and educators pay little attention to it (Dowhower, 1991; Rasinski, 1991).

The rauding theory is the third theory of fluency (Carlson et al., 2008). This theory's central focus is on the link between fluency and comprehension. Carlson et al. (2008) articulated this theory through three laws. Law I holds that readers attempt to understand a passage at a constant, fluent reading rate, called the rauding rate. Law II holds that efficiency of passage comprehension depends on the accuracy and rauding rate. Law III holds that the most efficient rate of comprehending is the rauding rate. In other words, the rauding theory defines fluency as the fastest rate at which a reader can efficiently understand complete thoughts in each sentence

(Carlson et al., 2008). Researchers (e.g., Dowhower, 1991; Nathan & Stanovich, 1991) concur with the rauding theory in that automaticity and rate alone do not define fluency. A level of comprehension must also be included for more complete fluency.

Fluency Research

Fluency research has been going on for decades, yet it has not received adequate attention until recently. The National Reading Panel, as well as other scholars, state that little research has been done on fluency, even though it is an essential component of efficient reading (Cunningham, 2001). However, in more recent years, researchers have "turned increasing attention toward unraveling the complexities of how reading fluency is developed and how it can be properly assessed" (Cunningham, 2001). In order to study the development of fluency, several researchers have conducted studies using various instructional methods that intended to increase reading fluency. Hasbrouck, Ihnot, and Rogers (1999) studied the effects that repeated readings and modeled reading fluency have on the reading fluency students in a Title I remedial and special education program, grades K-3. They used a program developed by Ihnot, called Read Naturally, a method of fluency instruction that included three techniques: reading from a model, repeated readings, and progress monitoring. These researchers found that their Read Naturally program had positive effects on the readers' reading fluency and comprehension, as well as student motivation.

A similar study on reading fluency was conducted by Rasinski, Padak, Linek, and Sturtevant (1994). Like Hasbrouck et al. (1999), these researchers also examined oral reading fluency, but through a different instructional model. Rasinski et al. (1994), created their own instructional model for oral reading fluency, which they called Fluency Development Lessons (FDL). Over the course of a year each student in the intervention classrooms participated in

FDL, which was a 10-15 minute instructional activity that included the following seven steps: a) teacher introduced text and invited prediction; b) teacher modeled fluent reading of the text; c) teacher led class discussion on the content of text; d) teacher led whole class in several choral readings of text; e) teacher divided students into pairs to read text three times; f) teacher invited students to read text in small groups to class; and g) students put away text, but were encouraged to read text on their own. The researchers found that, aside from the second graders' increased oral reading rate, no significant effects of the FDL were found. Although changes were limited, their work does suggest that instructional approaches, such as the FDL, may have potential for improving oral reading fluency of second grade students.

Several other researchers have also designed instructional methods to help students with slow, disfluent reading (e.g., Dowhower, 1987; Millin & Rinehart, 1999; Rasinski, 2000). While different fluency instructional methods were used and tested, research indicates that students' reading rate is increased through instructional programs that incorporate various repeated readings (e.g., Dowhower, 1987; Hasbrouck et al., 1999; Millin & Rinehart, 1999; Rasinski et al., 1994).

The National Reading Panel reviewed research-based studies on various aspects of reading, including fluency (Cunningham, 2001). They looked for generalizations on fluency that would help answer questions directed toward what fluency is and how it is increased. The NRP conducted a meta-analysis on 16 studies, with 752 subjects ranging from first grade to college. From their analysis, the NRP concluded that fluency is an essential component of reading, yet fluency instruction is missing in many classrooms. They recommended the use of guided oral repeated readings and increased independent reading as part of effective fluency instruction.

Even with these findings, reading fluency has continued and will continue to be an ongoing area of reading research (Cunningham, 2001).

Fluency and Comprehension

Reading Comprehension is the end goal of reading, yet it cannot be fully acquired when students are excessively slow at processing text (Rasinski, 2000). More than 20 years ago, comprehension was generally perceived as the ability to understand and construct meaning as the result of decoding oral language. Now researchers state that the ability to understand and make meaning from what is read comes from using the "clues from the text and their background knowledge to make sense of text" (Almasi, Madden, Hart, & Palmer, 2003, p. 74). Pressley (2002) supports this concept by saying if students understand the text and can interpret it, they have achieved comprehension. The ability to comprehend comes through the use of different cognitive resources. These abilities are any of those that distinguish a poor reader from a good reader (Stanovich, 1980).

Fluency instruction is an important component of any reading program, yet it is often ignored (Rasinski, 2000). Although reading comprehension is the overall desired outcome of reading, Rasinski (2000) states that inefficient, slow, choppy reading needs to be taken seriously. There may be differing causes for disfluent reading, but these obstacles can be addressed through engaging and authentic instructional methods and activities that are integrated into the regular reading curriculum.

Fluency Assessment: Dynamic Indicators of Basic Early Literacy Skills (DIBELS)

DIBELS Oral Reading Fluency (DORF; WPM, accuracy, and WR) measure builds on the work of Stanley L. Deno who developed the Curriculum Based Measurement Reading procedures at the University of Minnesota Institute for Research on Learning Disabilities (Deno, 1987; 2015). However, DORF passages are distinguished from other curriculum-based reading-procedures primarily by the specific set of passages that have been developed and by the specific procedures and criteria used to develop and arrange the passages for assessment. DORF passages are written according to specific criteria to ensure the appropriateness of the content. DORF includes a mix of different types of passages, with approximately two thirds of passages in first to third grades being narrative and one third being expository, and one third of passages in fourth to sixth grades being narrative and two thirds being expository. To prevent ceiling effects, the passage length in each grade is designed so that most students will not finish the passage in one minute.

Although DIBELS is being used in over 13,000 schools in the United States, often as part of the Reading First initiative, there is considerable controversy regarding the utility of the instrument (Olson, 2007). DIBELS's developers argue that the widespread use of DIBELS is supported by research, but its critics have suggested that political pressure to use DIBELS as part of Reading First is the reason for its widespread adoption (Goodman, 2006; Manzo, 2005).

One of the more common criticisms of DIBELS is that it is not an adequate indicator of reading comprehension (Goodman, 2006; Manzo, 2005). This criticism is important because both proponents and critics of DIBELS agree that comprehension is the ultimate goal of reading (Good, 2001; Goodman, 2006). If DIBELS subtests are closely connected to comprehension, they can be used to identify students at risk for comprehension difficulties and to provide additional instructional support to these students.

If DIBELS subtests are not closely related to comprehension, misallocation of resources will occur. For example, students with good comprehension skills but low DIBELS scores will receive unnecessary intervention services, whereas students with high DIBELS scores but poor comprehension could be excluded from useful intervention. It is not clear how closely reading comprehension is related to DIBELS tasks such as reading nonsense words (NWF) or pronouncing individual phonemes within words (PSF). Goodman (2006) provided a number of criticisms of these two DIBELS subtests.

First, he disagreed with a stepping-stone model that suggests that certain reading skills, such as phoneme segmentation, must be mastered before moving to the next skills (e.g., fluency, comprehension). A related concern is that poor student performance on these subtests will lead to reading instruction being focused on these specific skills (phoneme segmentation, decoding nonsense words) at the expense of other instructional strategies that would help overall reading ability (Goodman, 2006; Pearson, 2006). Goodman (2006) also noted that dialect or articulation differences across teachers and students may make it difficult to consistently administer and score the NWF and PSF. Dialect issues may affect English-language learners (ELLs) to an even greater degree. In addition, more accomplished readers may be slowed on the timed test by attempts to make meaning of nonsense words and may be penalized for a tendency to say real words that are spelled similarly to the nonsense words (Goodman, 2006).

On the DORF subtest, students read passages, and fluency is defined as the number of words read correctly in one minute. A student could read the words in the passage quickly, resulting in a high score, but still not comprehend the meaning of the text. Critics propose that the DORF task emphasizes speed rather than comprehension and may actually penalize students who are carefully searching for meaning within the text (Goodman, 2006; Pressley, Hilden, & Shankland, 2005). Samuels (2006) argued that DORF is not truly a measure of fluency because fluency involves decoding and comprehending at the same time, whereas the DORF task focuses on decoding speed but does not adequately assess comprehension. For example, ELLs may be able to decode text rapidly without comprehending the passage because of vocabulary difficulties (Samuels, 2006). The DORF task is followed by a retell fluency task designed to prevent students from speed reading without attempting to comprehend the passage. However, concerns have been raised about the ability to reliably score the retell fluency task and about its validity as a comprehension measure (Pressley et al., 2005).

An underlying concern that cuts across all DIBELS subtests is whether the information provided by DIBELS justifies the instructional time sacrificed to administer them. If DIBELS is a valid indicator of current and future reading comprehension ability, then its use could be justified for the purpose of screening, progress monitoring, and outcome assessment. A number of theoretical and practical concerns regarding DIBELS have been raised in the preceding paragraphs. The widespread use of DIBELS for measuring progress and guiding instructional decisions makes it imperative for researchers to continue to examine the validity of the instrument. In the following paragraphs, empirical evidence supporting the use of DIBELS is examined.

The strongest empirical support exists for the DORF subtest. There is a rich literature examining the use of an oral reading fluency task as a component of curriculum-based measurement (CBM; Fuchs, Fuchs, Hosp, & Jenkins, 2001). Both CBM ORF and DIBELS DORF involve reading connected text, and both operationally define fluency as the number of words read correctly in one minute. Although CBM and DRF do not directly measure comprehension, results from multiple studies indicate that oral reading fluency, defined as number of words from connected text read correctly per minute, is significantly correlated with comprehension scores (Fuchs, Fuchs, & Maxwell, 1988; Fuchs et al., 2001). Two studies found significant correlations of .67 (Good, 2001) and .70 (Buck & Torgesen, 2003) between CBM

DORF and state-mandated reading assessment scores for third-grade students. Also, support for an oral reading speed and comprehension relation is found outside of the CBM literature. A study using National Assessment of Educational Progress data from fourth-grade students found a positive relation between oral reading speed and reading comprehension (Daane, Campbell, Grigg, Goodman, & Oranje, 2005).

Findings with other measures of oral reading fluency may or may not generalize to DORF, and therefore the specific passages and methods used as part of DORF need to be examined directly. There is evidence that DORF scores are significantly correlated with comprehension skills, at least among third-grade students. Technical reports have documented statistically significant correlations (ranging from .73 to .80) between third-grade students' scores on the DORF and state- mandated assessments of reading (Barger, 2003; Wilson, 2005).

In contrast, Pressley and colleagues (2005) found a weaker correlation ($r = .45$) between DORF and TerraNova Reading scores among third-grade students. Pressley et al. proposed that their weaker correlations may have occurred because the TerraNova is a more comprehensive test of reading achievement than state-mandated tests, which may focus on lower level reading skills. Consequently, Pressley et al. (2005) called for further studies of DORF's relation with various reading measures out- side of state-mandated tests.

The emphasis on studying third-grade students leaves open the question of how appropriate DORF is for lower grades. Although it is recommended that administration of DORF begin in first grade, I found only one study that examined the relation between first-grade DORF scores and reading comprehension. A second study of first-grade students examined an alternative form of DORF that also was developed by the creators of DIBELS (Roberts, Good, & Corcoran, 2005).

Among a sample of first-grade students (n = 79) in rural Ohio, Cook (2003) found a correlation of .73 between DORF and the Stanford Achievement Test (9th edition) Reading Comprehension Cluster. Cook acknowledged the need for more studies on this topic given that her sample was relatively homogeneous with regard to socioeconomic status and included no minority students. Roberts et al. (2005) examined an alternative form of DORF developed for the Voyager Universal Literacy Program. In a sample of 86 first-grade students drawn from an urban school system, DORF scores were correlated at a statistically significant level (r = .76) with the Woodcock- Johnson Broad Reading Cluster, which includes letter–word identification tasks in addition to comprehension tasks. Both the Cook (2003) and the Roberts et al. (2005) studies examined concurrent relationships between first-grade DORF scores and comprehension. Therefore, the ability of first-grade DORF scores to predict future reading comprehension has not been established.

Few studies have investigated the relation between reading comprehension and the DIBELS phonological awareness (PSF) and alphabetic principle (NWF) tasks. The developers of DIBELS derived benchmarks for the PSF and NWF through extensive analyses looking at their relation to future DIBELS measures (e.g., DORF; Good, 2001; Good, Simmons, Kame'enui, Kaminski, & Wallin, 2002). These are important analyses, but they do not directly address the question of whether PSF and NWF can predict reading comprehension versus fluency as defined by DIBELS.

Cook (2003) did find a statistically significant correlation between the Stanford Comprehension Cluster and both the PSF (r = .38) and NWF (r = .61) in first-grade students. An additional study found statistically significant correlations between the Woodcock-Johnson Total Reading Cluster and the PSF and NWF (Good, 2001). However, it should be noted that the

Woodcock-Johnson Total reading cluster includes components other than comprehension, such as letter–word identification and reading fluency, which may have contributed to the significant correlations. Other researchers reported that the correlation between a word-identification fluency task using real words and comprehension was stronger than the correlation between DIBELS NWF and comprehension in a sample of at-risk first-grade students (Fuchs, Fuchs, & Compton, 2004). Two studies found no significant relation between first grade PSF scores and the Stanford Diagnostic Reading Test (Johnson, 1996; Kaminski & Good, 1996).

The studies that have examined the relation between PSF, NWF, and other reading measures provide preliminary evidence of a relation between these phonological processing tasks and comprehension.

According to its authors, DIBELS is a valid indicator of reading fluency, and can be used to "(a) identify children who may need additional support, and (b) monitor progress toward instructional goals" (p. 30). The DIBELS manual offers the following scientific justification for its assessment of oral reading fluency: DIBELS Oral Reading Fluency (DORF) is a standardized, individually administered test of accuracy and fluency with connected text. The DORF passages and procedures are based on the program of research and development of Curriculum Based Measurement [CBM] of reading by Stanley L. Deno at the University of Minnesota. A version of CBM Reading also has been published as The Test of Reading Fluency (TORF; Deno, 1987; 2015). A series of studies has confirmed the technical adequacy of CBM Reading procedures in general. Test reliabilities for elementary students ranged from .92 to .97; alternate-form reliability of different reading passages drawn from the same level ranged from .89 to .94 (Tindal, Marston, & Deno, 1982). Criterion-related validity studied in eight separate studies in the 1980s reported coefficients ranging from .52-.91 (Good & Jefferson, 1998; Good & Kaminski, 2002).

A final study by Wallace (2003), found DIBELS to be a reliable assessment of Letter Naming, Nonsense Word Fluency, and DIBELS Oral Reading Fluency (DORF). However, no measures of reading comprehension were addressed in this study. Furthermore, use of DIBELS did not help to close the achievement gap between higher and lower achieving students within each instruction program evaluated. A significant finding of this study was that "at the end of third grade [high-risk students] fell below all end-of-grade benchmarks and had not caught up to their lower risk peers" (Wallace, p. 219).

Children and Physical Activity

School-aged children should have opportunities to engage in physical activity across the school day as a way to enhance physical and mental health. With the recognition of diminished physical activity as a health risk factor associated with cardiovascular disease (World Health Organization [WHO], 2010), and the rapid declination of fitness in the United States (Tomkinson, Léger, Olds, & Cazorla, 2003), the importance of establishing healthy decision-making has increased. In addition to the well-established proximate benefits of childhood PA (i.e., increased cardiorespiratory, metabolic, musculoskeletal, functional, and emotional health including reduced risk factors for type 2 diabetes and obesity; WHO, 2010; Janssen & LeBlanc, 2010), behaviors in childhood and adolescence tend to track into adulthood (Telama et al., 2005). Also, the elevation of BMI among children increases the risk of cardiovascular disease later in life (Haque et al., 2008). It is important, therefore that school personnel intervenes early in a child's life by providing appropriate instruction and PA opportunities that have the potential to lead to a healthy lifestyle (Sallis et al., 1992).

Physical Activity Guidelines for School-Aged Children

Currently, national guidelines recommend that school-age children accumulate at least 60 minutes of PA per day, with a majority of those minutes spent in moderate to vigorous PA (MVPA; United States Department of Health and Human Services, 2008). A systematic review of the literature indicated a strong dose-response relationship between PA and numerous health indicators, concluding that engagement in PA as little as two to three hours per week can be beneficial. Also, strong evidence suggests the more daily PA children accrue, the greater the health benefit (Janssen & LeBlanc, 2010) especially considering that children who are physically active are more likely to become active adults (Trudeau, Laurencelle, & Shephard, 2004). Nevertheless, youth PA engagement remains well below professional guidelines and thus constitutes a serious public health issue (Strong et al., 2005). Utilizing accelerometry data, Troiano and colleagues (2008) found that only 42% of children meet daily PA guidelines with boys displaying significantly more PA than girls. Also, PA patterns decrease dramatically with age with only 6-8% of adolescents and 5% of adults accruing sufficient daily amounts.

Despite multiple warnings from the Surgeon General that children were becoming more sedentary (United States Department of Health and Human Services, 1996, 2008) sedentarism and subsequent unfavorable outcomes, including obesity, has continued to rise (Li et al., 2016). For example, a qualitative review of literature conducted by Tremblay and his colleagues (2011) on 232 studies indicated that children and adolescents (ages 5-17) who watched in excess of two hours of TV per day were more likely to have poor body composition, decreased fitness, reduced self-esteem and pro-social behavior, and diminished academic achievement compared to their peers who accrued less than two hours of TV viewing per day. As increased PA can improve children's health, schools can be an arena for increasing children's PA. Given the low levels of

PA among youth, this section of the review of literature is focused on physical activity interventions across the school day and its' subsequent known effects on children's cognition.

Physical Activity in Schools

Systematic accountability initiatives such as *No Child Left Behind* and *Race to the Top* have unintentionally produced outcomes that have contributed to the creation of obesogenic environments in schools. The Child Nutrition and WIC Reauthorization Act of 2004, which mandated that schools that receive federal funding establish and maintain wellness policies for nutrition and PA, required that all schools develop a wellness plan which includes parents, given the known physical and emotional benefits of both structured and unstructured PA (Ramstetter, Murray, & Garner, 2010). The academics first mentality coupled with a lack of evidence suggesting that a reduction in PA time will increase academic achievement in other subject areas (Trudeau & Shephard, 2008), placed pressure on school administrators to demonstrate that students were receiving sufficient instruction in academic areas such as mathematics and science. The required public reporting of student performance, through school report cards, meant that time in the daily schedule traditionally reserved for recess and physical education were now being dedicated to offering more time in math and science. In some cases, in a given six-hour day, a school-aged child could have no time for physical activity, as only 6% of schools have daily physical education and 16% have daily recess (Center for Disease Control and Prevention, 2015).

Despite the magnitude of such unintended outcomes, schools remain an ideal place to offer opportunities for children to be physically active, for several reasons. First, most children attend school (Wechsler, McKenna, Lee, & Dietz, 2004), thus affording the potential for the greatest reach across cultures and demographics. Second, children who participate in the whole-of-school approach can accumulate most of their daily MVPA in school (Beighle, Morgan, Le Masurier, & Pangrazi, 2006). Third, most schools have developmentally appropriate space for promoting both structured (e.g., physical education in a gymnasium) and unstructured physical activity (e.g., on the playground at recess; Pate et al., 2006). While these three reasons are inherently true, such an approach requires physical educators and other school personnel to rethink their roles surrounding the provision of PA (Sallis et al., 2012; Sallis & McKenzie, 1991). Several intervention efforts targeting youth in schools have sought to reverse the philosophy that health and academics are mutually exclusive (Ahamed et al., 2007).

Now, however, in response to the accelerating obesity epidemic, a unique partnering of agencies and organizations have pooled resources in a combined effort toward enhanced childhood PA and wellness. Also, since the publication of the PA guidelines, many researchers are shifting focus from skill acquisition to PA and fitness in physical education. A recent review of 262 peer-reviewed journal articles revealed that a majority of published research in physical education now stems from inquiry concerning student PA rather than psychomotor development or game performance (Li et al., 2016). This trend may represent a tilt toward a more public health approach to physical education specifically and schools generally (Sallis & McKenzie, 1991). However, randomized group-controlled trials are still underrepresented in the literature (Li et al., 2016). Nevertheless, it appears clear that the responsibility for the enhancement of children’s health through enhanced PA must extend beyond the formal physical education teacher to include the entire school's staff since children are sedentary most of the school day (Abbott, Straker, & Mathiassen, 2013).

Coordinated Health Models in Schools

Although recent coordinated health models, defined as multi-component initiatives that involve the use of common messaging and shared resources, have seen a more concerted effort toward increasing the PA of children in the US, the concept of coordinated health models have existed in some form since the 1930's (Erwin, Beighle, Carson, & Castelli, 2013). What may be new is the conception of targeting specific points of intervention, facilitated by a champion. The Whole School, Whole Community, Whole Child (WSCC) model is a comprehensive, child-centered, multi-component model which seeks greater alignment, integration, and collaboration across sectors of health and education. This model expands previous models to the following ten components: (a) health education; (b) nutrition environment and services; (c) employee wellness; (d) social and emotional school climate; (e) physical environment; (f) health services; (g) counseling, psychological, and social services; (d) community involvement; (e) family engagement; and, (f) physical education and physical activity (Association for Supervision and Curriculum Development, 2019).

Many Texas schools have adopted a collaborative approach to school health. The term "coordinated school health" was adopted by the CDC in 2007 (Centers for Disease Control and Prevention, 2015). In 2008, Texas mandated that schools adopt a coordinated school health (CSH) model and ensure that students obtain a minimum of 135 minutes of PA per week with a majority of those minutes engaged in MVPA (Cooper et al., 2010).

The original CSH model is comprised of eight components: (a) health education; (b) physical education; (c) health services; (d) nutrition services; (e) counseling and psychological services; (f) healthy school environment; (g) health promotion for staff; (h) family and community involvement.

In 2008, NASPE (now known as SHAPE America) endorsed a PA-centered approach to school health referred to as a Comprehensive School Physical Activity Program (CSPAP).

Similar to CSH, a comprehensive school physical activity program (CSPAP) is a whole-of-school approach (Institute of Medicine, 2013) that builds upon the CSH model while targeting increased physical activity through school faculty, family, and community involvement. Specifically, a CSPAP is comprised of 5 components: (a) quality physical education; (b) physical activity during school; (c) physical activity before and after school; (d) family and community engagement; and, (e) staff involvement (Advanced Solutions International, Inc., 2001).

Comprehensive School Physical Activity Program (CSPAP) and Physical Activity (PA) Interventions

By targeting specific programs, times in a daily schedule or individuals who can support PA opportunities for children, CSPAP may become an effective WSCC model. Initial research suggests that CSPAP can be effective in increasing student PA throughout the school day (Centeio, McCaughtry, et al., 2014; Goh et al., 2014) and that physical educators are receptive to the challenge (Centeio, Erwin, & Castelli, 2014). Additionally, within the context of a CSPAP, classroom teachers can significantly enhance students' daily PA (Goh et al., 2014) and quality physical educators operating within a CSPAP have been reported to increase student activity levels (Chen, Hypnar, Mason, & Zalmout, 2014). A comprehensive approach has also been reported to significantly increase both students and parents PA in urban settings (Centeio, McCaughtry, et al., 2014). However, several questions remain about the training and preparation needed for physical educators and other faculty members to fully embrace the responsibilities and opportunities of championing a CSPAP (Kelder, Karp, Scruggs, & Brown, 2014). For example, McMullen, van der Mars, and Jahn (2014) found that preservice physical education students had difficulties interacting with high school students outside of a traditional physical education class and distinguishing between their roles as a teacher of physical education and a promoter of PA. The authors assert the necessity of preparing PETE majors early in their undergraduate program for the expanded vision and roles inherent within a CSPAP. Others have noted that while the basic principles of a CSPAP appear to be sound, each school must tailor their programs to meet their individual needs and context (Jones et al., 2014).

Although relatively few schools in the US currently employ all five CSPAP components (Jones et al., 2014) several schools may be partial implementers. It is noteworthy that a CSPAP is a framework for the organization of PA, but many districts, schools, and individual teachers have been applying its' principles, at least in part, for some years. For example, Ernst and Pangrazi (1999) observed that students' school PA increased significantly when district and school interventions were in place. However, results from the study remain unclear as student PA was measured through self-assessment. A follow-up study by Pangrazi, Beighle, Vehige, and Vack (2003) using pedometers, examined 35 Arizona elementary schools' implementation of a school PA intervention termed Promoting Lifestyle Activity in Youth (PLAY). Researchers noted that PLAY was utilized as a supplemental PA response and not a replacement for physical education. They observed that the treatment effectively increased student PA levels, especially for girls. This study may be particularly informative as boys are routinely more physically active than females (Troiano et al., 2008). Likewise, research in Canada has demonstrated the feasibility of whole-school approaches toward incremental increases of student PA across the school day, particularly when involving the family and community (Naylor, Macdonald, Zebedee, Reed, & McKay, 2006). Similarly, recent research in Australia among secondary students illustrates the efficacy of multicomponent whole-school approaches (Sutherland et al., 2016). Nevertheless, several barriers remain which hinder the transfer from theory to practice including teacher overload, shortage of resources, teacher and administrator buy-in, and feasibility issues related to transportation and legal concerns (Jones et al., 2014), therefore, additional research on school PA interventions has been called for (Dobbins, Husson, DeCorby, & LaRocca, 2013). Several intervention efforts targeting children in schools have sought to reverse the idea that health and academics are mutually exclusive (Ahamed et al., 2007).

Physical Activity and Academic Achievement

In children, academic achievement (AA) can be identified as the realization of educational goals measured by assessment (Howie, Schatz, & Pate, 2015). Children who are physically active in schools for single short bouts on a daily basis reap multiple physical and cognitive benefits. Acute bouts of PA, defined as a single session of PA of short duration (generally less than 60 minutes), have been linked to greater AA with school-aged children (Hillman et al., 2009; Howie, Schatz, & Pate, 2015). For example, Phillips, Hannon, and Castelli (2015) utilized a within-subjects experimental design with two 8th grade physical education classes to determine the effect of vigorous, acute exercise on mathematics test performance. Results suggest that vigorous, acute PA may increase mathematics performance for up to 30 minutes post exercise.

In addition, when students engage in regular or chronic PA, defined as meeting the daily PA recommendations, the relationship between PA and academic achievement is even more robust (Castelli et al., 2014; Castelli, Hillman, Buck, & Erwin, 2007; Castelli, Hillman, Hirsch, Hirsch, & Drollette, 2011; Chomitz et al., 2009; Grissom, 2005; Kamijo et al., 2014; Rasberry et al., 2011; Welk et al., 2010), particularly when PA is aerobic-based (Fedewa & Ahn, 2011). These studies suggest that when children participate in regular PA they can enhance physical fitness and thereby also enhance their academic achievement. Most studies examine elementary children beginning in third grade presumably because that is when mandated fitness testing in physical education and state academic testing in the classroom begins. Research in schools often utilizes FITNESSGRAM data as a valid measure of physical fitness (specifically the PACER test which measures cardiorespiratory endurance), and standardized tests as a measure of academic achievement. For example, in a cross-sectional study of 259 third and fifth-grade students in Illinois, utilizing FITNESSGRAM and standardized math and reading achievement data found a positive relationship between students' fitness and reading, math, and total academic achievement. That is, those students who were more physically fit were more likely to perform better in school (Castelli et al., 2007). Two years later, Chomitz et al. (2009) employed a cross-sectional design examining state academic achievement tests and fitness tests conducted in physical education. They found a significant positive relationship between students' overall physical fitness and academic achievement. Larger studies like the one carried out in California among fifth, seventh and ninth grade students (N=1989) revealed a positive association between fitness and academic achievement and a negative association between Body Mass Index (BMI) and academic achievement after controlling for age, socioeconomic status, sex, and ethnicity (Roberts, Freed, & McCarthy, 2010). Several more studies have similar conclusions (i.e., Chih & Chen, 2011; Sallis et al., 1999) with one study finding a positive relationship with time spent in physical education and AA among girls (Carlson et al., 2008).

The results of this research are encouraging. Taken together, these studies indicate that there exists a universal positive relationship between physical fitness and AA in school-aged children and that efforts to reallocate time toward PA in schools are justified and timely. Still, little is known about the specific dose of PA necessary to produce a substantive change in children's academic achievement and though there is some evidence that children who engage in more vigorous PA over time experience greater academic gains (Castelli et al., 2011) more research is needed to understand the dose-response of PA and AA better.

Physical Activity and Executive Function Among Children

One additional way to measure the processes affiliated with learning is to focus on the notion that information processing is a major factor in learning. Executive function (EF), broadly speaking, is an overarching term understood as effortful, goal-oriented, cognitive functions necessary to concentrate and pay attention (Norman & Shallice, 1986), which underlie AA (Hillman, Kamijo, & Scudder, 2011). How one schedules, plans, and prioritizes information is organized into four subcomponents of attention, inhibition, working memory, and cognitive flexibility (Miyake et al., 2000; Norman & Shallice, 1986). Inhibition (or inhibitory control) involves the ability to ignore distracting stimuli. Working memory permits the retention of and ability to mentally manipulate information. Cognitive flexibility permits the switching of attention between competing tasks (Davidson, Amso, Anderson, & Diamond, 2006). These cognitive processes are theorized to be malleable, essential for self-directed behavior (Banich, 2009) and particularly sensitive to exercise (Hillman et al., 2011); therefore, interventions that increase EF in the elementary years may be especially useful in facilitating children's learning.

PA engagement has been demonstrated to improve executive functions underlying learning in both chronic, that is repeated, and acute, or single, sessions (Best & Miller, 2010; Hillman et al., 2009; Hillman et al., 2014; Kamijo et al., 2014; Tomporowski, Lambourne, & Okumura, 2011). As early as 1979, a study involving second graders concluded that fifty minutes of PA may improve student alertness and subsequent performance on academic tasks given five minutes after exertion (Gabbard & Barton, 1979). Research conducted by Davis et al. (2007)

revealed that overweight children who engaged in consistent, vigorous exercise (40 minutes per day) for five days per week, over 15 weeks, displayed significant gains in EF pre-to-post intervention. Children with lower doses of PA, however, showed no improvement. This study may be particularly informative when considering both the dose of PA and the fitness level of the child. For instance, it has been observed that fitness level may have a mediating effect on the relationship between PA and EF. In other words, students who are categorically unfit but who engage in PA for a sustained amount of time may experience more cognitive benefits than their more fit peers. The implication then is that schools that champion PA across the school day serves the dual purpose of improving the health and cognitive functioning of those most in need. However, it is important to consider the total volume of PA as measured in frequency, duration, and intensity as some evidence concludes that the intensity of children's PA may be particularly salient in enhancing children's cognitive processes (Phillips et al., 2015).

Also, a recent cross-sectional study in the Netherlands revealed an inverse relationship between sedentary behavior and inhibition and a positive relationship between PA and planning for children ages 8-12 (van der Niet et al., 2015). Another recent study conducted by Davis, Tkacz, Tomporowski, and Bustamente (2015) examined the independent relationships of PA and weight status on children's EF. Children who were both normal weight and active displayed higher planning and attention scores than overweight, inactive children while normal weight inactive children had a higher attention score than overweight, inactive children. Children who were normal weight and active exhibited higher planning and attention scores than normal weight inactive children. The results of this study are both practical and significant as it demonstrates the importance of children's weight status and PA on EF, thus corroborating earlier research implying physical fitness as a mediator between exercise training and cognitive functions (Tomporowski et al., 2011).

Perhaps one of the most oft-referenced studies examining acute PA and EF is Hillman et al. (2009) which utilized a within-subjects repeated measures design with 20 children in a lab setting. Participants were measured after 20 minutes of walking on a treadmill and 20 minutes of resting with no intervention. Participants were randomly selected (10 in each group) to participate in walking or resting activities first. Findings revealed that 20 minutes of walking on a treadmill at moderate intensity had significant beneficial effects on inhibitory control and reading comprehension while the resting condition showed no differences between their pre and post-test scores. This study was pivotal and timely as it carved out a line of research about acute bouts of PA and its' effects on cognitive function. That same year, researchers found that 7 and 10-year-old children who engaged in stationary cycling for 40 minutes demonstrated enhanced response time over their inactive peers (Pesce, Crova, Cereatti, Casella, & Bellucci, 2009).

Although laboratory research has shown effects of PA on executive functions that subserve learning, researchers have called for further research with children in school settings in order to more fully understand the effect of PA on children's cognition in an ecologically valid setting (Castelli et al., 2014; Phillips et al., 2015). While some teachers are currently employing PA breaks in the classroom most of the existing research focuses on chronic PA rather than acute PA sessions and thus the cognitive effects of short bouts of PA are largely unknown among school-aged children (Howie et al., 2015).

Classroom PA and Cognitive Function

As part of a CSPAP, classroom teachers have implemented PA breaks for the purpose of resetting attention and teaching academic content through movement (Erwin et al., 2013).

Classroom teachers are particularly well-positioned to facilitate student PA acquisition as students spend a majority of their time in classrooms and with their classroom teachers in other settings (Donnelly & Lambourne, 2011). However, classroom PA has been shown to account for less than 5% of total daily PA among children (Brusseau et al., 2011) even though the implementation of classroom PA may be a feasible way to significantly increase children's PA (Trost, Fees, & Dzewaltowski, 2008).

Within classrooms, a teacher may choose to implement an entire curriculum of physically active lessons (e.g., TAKE 10!®; Stewart, Dennison, Kohl, & Doyle, 2004) or simply have the resources on hand to utilize during transitions throughout the day (Erwin et al., 2013). Moreover, classroom PA can involve blending content with PA (sometimes called physically active lessons) or incorporated as a break from academics (sometimes termed brain breaks; Bartholomew and Jowers, 2011).

Emerging research suggests that classroom PA is generally feasible and can significantly. increase students' classroom PA (Erwin, Beighle, Morgan, & Noland, 2011; Phillips, Hannon, & Castelli, 2014), particularly when the teacher is an active participant (Donnelly et al., 2009; Ernst & Pangrazi, 1999). Furthermore, when children engage in classroom PA, they are more likely to not only demonstrate subsequent on-task behavior during academic tasks (Grieco, Jowers, & Bartholomew, 2009; Mahar et al., 2006) but also score higher on standardized tests (Donnelly & Lambourne, 2011). However, few studies have examined the cognitive response of acute classroom PA breaks.

In 2006, Mahar and his colleagues examined the effects of PA breaks on school-day PA and on-task behavior. Fifteen elementary classes (first-fourth grade) were divided into control and treatment groups. Teachers in the treatment group employed one 10-minute PA break (termed an Energizer) each school day for eight weeks, while classes in the control group did not utilize Energizers for the duration of the intervention. Results indicated that students who engaged in Energizers accrued significantly more PA (steps measured via pedometer) and demonstrated on-task behaviors more often than their peers in the control group.

A comparable study using a within-subjects design, Grieco, Jowers, and Bartholomew (2009) examined 97 third-grade students across nine classrooms divided into treatment and control groups. Students in the treatment groups engaged in "Texas I-Can" active lessons throughout the school year while those in the control group did not participate. Similar to Mahar et al. (2006), on task behavior improved following an active lesson and decreased following an inactive lesson. However, this study additionally examined the compensatory effects of BMI on time-on-task (TOT). The results concluded that BMI was inversely associated with TOT. The authors find that "BMI moderates the impact of physical activity on TOT" (Mahar et al., p. 1925).

Notwithstanding the likely effects of PA breaks on EF, the optimal duration of the PA break is not clear. A 2009 study in Germany examined 81 seventh-grade students to determine the effects of a five-minute classroom exercise break and a 30-minute aerobic physical education lesson on EF. The results indicate that students who engaged in 30 minutes of physical education had significantly enhanced on-task attention whereas those who participated in the 5-minute PA break displayed no pre-to-post differences (Kubesch et al., 2009).

Guided by the following three studies, a recent study by Howie, Schatz, and Pate (2015) examined the dose-response relationship of varying durations of classroom PA breaks on students' cognitive functions. Again, employing a within-subjects experimental design, fourth- and fifth-grade students were divided into treatment groups of sedentary, or 5-, 10-, and 20-, minute classroom PA breaks, with the only manipulation being the duration of the PA. Students were measured on three cognitive tasks: Trail Making Test, digit recall and timed math test. Results revealed a significant increase in math scores after 10- and 20-minutes but not after 5-minutes or with the sedentary group. No other significant differences were found about the PA durations, digit recall, and Trail Making Test. This study represents "the first study to directly compare the acute effects of varying doses of classroom exercise breaks on acute cognitive effects" (Howie et al. p. 221) and therefore is a significant contribution to the extant literature. However, although the researchers utilized the System for Observing Fitness Instruction Time (SOFIT) the intensity of the students' PA engagement within each treatment condition remains unclear as no objective measures were used (i.e., accelerometer, pedometer). Given that relatively few studies examining the academic and health effects of classroom PA has been published in peer-reviewed journals, more research is warranted (Erwin, Fedewa, Beighle, & Ahn, 2012).

Staff Involvement as a Portion of CSPAP

A recent study by Turner and Chaloupka (2016) utilized survey data from 640 public elementary schools to examine the current reach and implementation of PA in elementary school classrooms. While 75% of schools surveyed reported the use of some type of classroom movement integration, those who were predominantly White and higher socioeconomic status were significantly more likely to implement PA. The authors conclude that the reach of PA in elementary school classrooms is low and additional research is warranted.

Although, collectively speaking, "teachers are [still] employing little or no integration of movement into their classrooms," derived from an overemphasis on academic accountability measures (Parks, Solmon, & Lee, 2007, pg. 325) in some cases, teachers respond positively to the notion of increasing student PA if they are given the proper training (Naylor et al., 2006) and school support (Erwin, Fedewa, Beighle, & Ahn, 2012) to do so. However, some teachers, though not philosophically opposed to classroom PA, still find it difficult to incorporate into the curriculum because of the lack of time or external expectations about standardized test scores (Cothran, Kulinna, & Garn, 2010). The notion of teachers caring for students' lives beyond their classroom and teacher interest convergence about student PA are likely mediators for teacher promotion of PA and may supersede structural barriers (Cothran et al., 2010). Conversely, some research indicates that classroom teachers have an unfavorable view or lack the self-efficacy necessary to include daily PA in their classrooms (Faucette, Nugent, Sallis, & McKenzie, 2002) even when they are personally physically active (Parks et al., 2007).

Scholars have indicated that teacher's perceptions of classroom control (including chaos, space constraints and getting students back on task), may also impact a teacher's decision to use PA breaks. Other factors include ease and enjoyment, and whether the PA breaks can be incorporated into the existing curriculum (McMullen, Kulinna, & Cothran, 2014). The authors assert that the introduction of these skills in preservice programs and their continual reinforcement through the provision of resources and periodic training may help the concept of the student movement in the classroom be less "disconcerting" to the classroom teacher. Other researchers likewise conclude that having facilitator-support greatly increased the likelihood that teachers would use PA breaks (Delk, Springer, Kelder, & Grayless, 2014).

References

Abbott, R. A., Straker, L. M., & Mathiassen, E. S. (2013). Patterning of children's sedentary time at and away from school. *Obesity*, *21*(1), E131–E133.

Advanced Solutions International, Inc. (2001). What is CSPAP? Retrieved from https://www.shapeamerica.org/cspap/what.aspx

Ahamed, Y., Macdonald, H., Reed, K., Naylor, P.-J., Liu-Ambrose, T., & Mckay, H. (2007). School-based physical activity does not compromise children's academic performance. *Medicine and Science in Sports and Exercise*, *39*(2), 371.

Almasi, J. F., Madden, A., Hart, S., & Palmer, B. M. (2003). Interventions to enhance narrative comprehension. In A. McGill-Franzen, R. L. Allington, G. Hruby, J. Elkins, P. Johnston, S. J. Samuels, S. Hupp, V. Risko, P. Anders, W. Rupley, & V. L. Willson (Eds.), *Handbook of Reading Disability Research* (pp. 329-339). doi:10.4324/9780203853016.ch30

Banich, M. T. (2009). Executive function the search for an integrated account. *Current Directions in Psychological Science*, *18*(2), 89–94.

Barger, V. (2003). State Mandated Assessment on the Psych of Elementary-Aged Students. *Pediatric Science Education, 576*(3-4), 303-308. doi:10.1016/j.physletb.2003.10.004

Bartholomew, J. B., & Jowers, E. M. (2011). Physically active academic lessons in elementary children. *Preventive Medicine*, *52*(1), S51–S54.

Beighle, A., Morgan, C. F., Le Masurier, G., & Pangrazi, R. P. (2006). Children's physical activity during recess and outside of school. *Journal of School Health*, *76*(10), 516–520.

Best, J. R., & Miller, P. H. (2010). A developmental perspective on executive function. *Child Development*, *81*(6), 1641–1660.

Brusseau, T. A., Kulinna, P. H., Tudor-Locke, C., Ferry, M., Van Der Mars, H., & Darst, P. W. (2011). Pedometer-determined segmented physical activity patterns of fourth- and fifth-grade children. *Journal of Physical Activity and Health*, *8*(2), 279.

Buck, E. M., & Torgesen, J. K. (2003). The Prevention of Reading Difficulties. *Journal of School Psychology, 40*(1), 7-26. doi:10.1016/s0022-4405(01)00092-9

Carlson, S. A., Fulton, J. E., Lee, S. M., Maynard, L. M., Brown, D. R., Kohl III, H. W., & Dietz, W. H. (2008). Physical education and academic achievement in elementary school: Data from the early childhood longitudinal study. *American Journal of Public Health*, *98*(4), 721–727.

Castelli, D. M., Centeio, E. E., Hwang, J., Barcelona, J. M., Glowacki, E. M., Calvert, H. G., & Nicksic, H. M. (2014). The history of physical activity and academic performance research: informing the future. *Monographs of the Society for Research in Child Development*, *79*(4), 119–148.

Castelli, D. M., Hillman, C. H., Buck, S. M., Erwin, H. E. (2007). Physical fitness and academic achievement in third- and fifth-grade students. *Journal of Sport and Exercise Psychology*, *29*(2), 239.

Castelli, D. M., Hillman, C. H., Hirsch, J., Hirsch, A., & Drollette, E. (2011). FIT Kids: Time in target heart zone and cognitive performance. *Preventive Medicine*, *52*(1), S55–S59.

Centeio, E. E., Erwin, H., & Castelli, D. M. (2014). Comprehensive school physical activity programs: Characteristics of trained teachers. *Journal of Teaching in Physical Education*, *33*(4), 492–510.

Centeio, E. E., McCaughtry, N., Gutuskey, L., Somers, C. L., Shen, B., Martin, J., & Kulik, N. (2014). Physical activity change through comprehensive school physical activity programs in urban elementary schools. *Journal of Teaching in Physical Education*, *33*(4), 573–591.

Chen, W., Hypnar, A. J., Mason, S. A., & Zalmout, S. (2014). students' daily physical activity behaviors: The role of quality physical education in a comprehensive school physical activity program. *Journal of Teaching in Physical Education*, *33*(4), 592–610.

Chih, C. H., & Chen, J.-F. (2011). The relationship between physical education performance, fitness tests and academic achievement in elementary school. *International Journal of Sport & Society*, *2*(1), 10-17.

Chomitz, V. R., Slining, M. M., McGowan, R. J., Mitchell, S. E., Dawson, G. F., & Hacker, K. A. (2009). Is there a relationship between physical fitness and academic achievement? Positive results from public school children in the northeastern United States. *Journal of School Health*, *79*(1), 30–37.

Cooper, K. H., Everett, D., Meredith, M. D., Kloster, J., Rathbone, M., & Read, K. (2010). Preface: Texas statewide assessment of youth fitness. *Research Quarterly for Exercise and Sport*, *81*(sup3), ii–iv.

Cothran, D. J., Kulinna, P. H., & Garn, A. C. (2010). Classroom teachers and physical activity integration. *Teaching and Teacher Education*, *26*(7), 1381–1388.

Cunningham, J. W. (2001). The National Reading Panel Report. *Reading Research Quarterly,36*(3), 326-335. doi:10.1598/rrq.36.3.5

Daane, P. L., Campbell, M. C., Grigg, W. C., Goodman, E. R., & Oranje, N. B. (2005). The Nations Report Card: Reading Highlights 2003. *PsycEXTRA Dataset*. doi:10.1037/e609922011-007

Davidson, M. C., Amso, D., Anderson, L. C., & Diamond, A. (2006). Development of cognitive control and executive functions from 4 to 13 years: Evidence from manipulations of memory, inhibition, and task switching. *Neuropsychologia*, *44*(11), 2037–2078.

Davis, C. L., Tkacz, J. P., Tomporowski, P. D., & Bustamante, E. E. (2015). Independent associations of organized physical activity and weight status with children's cognitive functioning: A matched-pairs design. *Pediatric Exercise Science*, *27*(4), 477–487.

Davis, C. L., Tomporowski, P. D., Boyle, C. A., Waller, J. L., Miller, P. H., Naglieri, J. A., & Gregoski, M. (2007). Effects of aerobic exercise on overweight children's cognitive functioning: a randomized controlled trial. *Research Quarterly for Exercise and Sport*, *78*(5), 510–519.

Delk, J., Springer, A. E., Kelder, S. H., & Grayless, M. (2014). Promoting teacher adoption of physical activity breaks in the classroom: Findings of the Central Texas CATCH Middle School Project. *Journal of School Health*, *84*(11), 722–730.

Deno, S. L. (1987). Curriculum-Based Measurement. TEACHING Exceptional Children, 20(1), 40–42. https://doi.org/10.1177/004005998702000109

Deno, S. L. (2015). Data-based decision-making. In S. R. Jimerson, M. K. Burns, & A. M. VanDerHeyden (Eds.), *Handbook of response to intervention* (pp. 9-28). New York, NY: Springer Science + Business Media. doi:10.1007/978-1-4899-7568-3_2

Dobbins, M., Husson, H., DeCorby, K., & LaRocca, R. L. (2013). School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database Systematic Reviews*, *2*(2).

Donnelly, J. E., Greene, J. L., Gibson, C. A., Smith, B. K., Washburn, R. A., Sullivan, D. K., . . . Williams, S. L. (2009). Physical Activity Across the Curriculum (PAAC): A randomized controlled trial to promote physical activity and diminish overweight and obesity in elementary school children. *Preventive Medicine*, *49*(4), 336–341.

Donnelly, J. E., & Lambourne, K. (2011). Classroom-based physical activity, cognition, and academic achievement. *Preventive Medicine*, *52*, S36–S42.

Dowhower, S. L. (1987). effects of repeated reading on second-grade transitional readers fluency and comprehension. *Reading Research Quarterly, 22*(4), 389-399. doi:10.2307/747699

Dowhower, S. L. (1991). Speaking of prosody: Fluency's unattended bedfellow. *Theory into Practice, 30*(3), 165-175. doi:10.1080/00405849109543497

Ernst, M. P., & Pangrazi, R. P. (1999). Effects of a physical activity program on children's activity levels and attraction to physical activity. *Pediatric Exercise Science*, *11*(4), 393–405.

Erwin, H., Beighle, A., Carson, R. L., & Castelli, D. M. (2013). Comprehensive school-based physical activity promotion: A review. *Quest*, *65*(4), 412–428.

Erwin, H. E., Beighle, A., Morgan, C. F., & Noland, M. (2011). Effect of a low-cost, teacher-directed classroom intervention on elementary students' physical activity. *Journal of School Health*, *81*(8), 455–461.

Erwin, H., Fedewa, A., Beighle, A., & Ahn, S. (2012). A quantitative review of physical activity, health, and learning outcomes associated with classroom-based physical activity interventions. *Journal of Applied School Psychology*, *28*(1), 14–36.

Faucette, N., Nugent, P., Sallis, J. F., & McKenzie, T. L. (2002). "I'd rather chew on aluminum foil." Overcoming classroom teachers' resistance to teaching physical education. *Journal of Teaching in Physical Education*, *21*(3), 287–308.

Fedewa, A. L., & Ahn, S. (2011). The effects of physical activity and physical fitness on children's achievement and cognitive outcomes: A meta-analysis. *Research Quarterly for Exercise and Sport*, *82*(3), 521–535.

Fuchs, D., Fuchs, L. S., & Compton, D. L. (2004). Identifying reading disabilities by responsiveness-to-instruction: Specifying measures and criteria. *Learning Disability Quarterly, 27*(4), 216-227. doi:10.2307/1593674

Fuchs, L. S., Fuchs, D., Hosp, M. K., & Jenkins, J. R. (2001). Oral reading fluency as an indicator of reading competence: A theoretical, empirical, and historical analysis. *Scientific Studies of Reading, 5*(3), 239-256. doi:10.1207/s1532799xssr0503_3

Fuchs, L. S., Fuchs, D., & Maxwell, L. (1988). The validity of informal reading comprehension measures. *Remedial and Special Education, 9*(2), 20-28. doi:10.1177/074193258800900206

Gabbard, C., & Barton, J. (1979). Effects of physical activity on mathematical computation among young children. *Journal of Psychology*, *103*(2), 287-293.

Goh, T. L., Hannon, J. C., Brusseau, T. A., Webster, C., Podlog, L., & Newton, M. (2014). Effects of a classroom based physical activity program on children's physical activity levels. *Journal of Teaching in Physical Education*, *33*(4), 558–572.

Good, P. I. (2001). Hypothesis testing. *Resampling Methods,* 40-59. doi:10.1007/978-1-4757-3425-6_3

Good, C., & Jefferson, D. (1998). Curriculum-Based Measurement of Oral Reading fluency (CBM-R): An objective orientated evaluation study. *Support for Learning, 29*(4), 370-393. doi:10.1111/1467-9604.12067

Good, C., & Kaminski, J. (2002). The Good of Reading. *Teaching Bodies*. doi:10.5422/fordham/9780823273782.003.0012

Good, M., Simmons, T., Kame'enui, J., Kaminski, J., & Wallin, S. (2002). Kindergarten to the first-grade analysis of reading assessments. *Education Quarterly, 40*(1), 12-17. doi: 10.1016/j.stueduc.2013.11.008

Goodman, M. (2006). Defending referrals between consultants. *BMJ, 332*(7537-7565). doi:10.1136/bmj.332.7537.371

Grieco, L. A., Jowers, E. M., & Bartholomew, J. B. (2009). Physically active academic lessons and time on task: The moderating effect of body mass index. *Medicine and Science in Sports and Exercise, 41*(10), 1921–1926.

Grissom, J. B. (2005). Physical fitness and academic achievement. *Journal of Exercise Physiology Online*, *8*(1), 11–25.

Haque, A. K., Gadre, S., Taylor, J., Haque, S. A., Freeman, D., & Duarte, A. (2008). Pulmonary and cardiovascular complications of obesity: An autopsy study of 76 obese subjects. *Archives of Pathology & Laboratory Medicine*, *132*(9), 1397–1404.

Hasbrouck, J. E., Ihnot, C., & Rogers, G. H. (1999). “Read naturally”: A strategy to increase oral reading fluency. *Reading Research and Instruction, 39*(1), 27–37. doi:10.1080/19388079909558310

Hillman, C. H., Kamijo, K., & Scudder, M. (2011). A review of chronic and acute physical activity participation on neuroelectric measures of brain health and cognition during childhood. *Preventive Medicine*, *52*(1), S21–S28.

Hillman, C. H., Pontifex, M. B., Castelli, D. M., Khan, N. A., Raine, L. B., Scudder, M. R., … Kamijo, K. (2014). Effects of the FITKids randomized controlled trial on executive control and brain function. *Pediatrics*, *134*(4), e1063–e1071.

Hillman, C. H., Pontifex, M. B., Raine, L. B., Castelli, D. M., Hall, E. E., & Kramer, A. F. (2009). The effect of acute treadmill walking on cognitive control and academic achievement in preadolescent children. *Neuroscience*, *159*(3), 1044–1054.

Howie, E. K., Schatz, J., & Pate, R. R. (2015). Acute effects of classroom exercise breaks on executive function and math performance: A dose–response study. *Research Quarterly for Exercise and Sport*, *86*(3), 217–224.

Institute of Medicine. (2013). *Educating the student body: Taking physical activity and physical education to school.* Washington, DC: National Academies Press.

Janssen, I., & LeBlanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, *7*(1), 40.

Johnson, M. L. (1996). The effect of premise order on the making of transitive inferences by first and second grade children. *School Science and Mathematics,77*(5), 429-433. doi:10.1111/j.1949-8594.1977.tb09279.x

Jones, E. M., Taliaferro, A. R., Elliott, E. M., Bulger, S., Kristjansson, A. L., Neal, W., . . . Allar, I. (2014). Feasibility study of comprehensive school physical activity programs in

Appalachian communities: The McDowell CHOICES project. *Journal of Teaching in Physical Education*, *33*(4), 467–491.

Kamijo, K., Pontifex, M. B., Khan, N. A., Raine, L. B., Scudder, M. R., Drollette, E. S., . . . Hillman, C. H. (2014). The negative association of childhood obesity to cognitive control of action monitoring. *Cerebral Cortex*, *24*(3), 654–662.

Kaminski, R. A., & Good, R. H. (1996). Assessment for instructional decisions: Toward a proactive/prevention model of decision-making for early literacy skills. *School Psychology Quarterly,11*(4), 326-336. doi:10.1037/h0088938

Wallace, C. (2003). Critical reading revisited: Diaries, reading protocols, and interviews. In *Critical reading in language education* (pp. 156-191). London, UK: Palgrave Macmillan. doi:10.1057/9780230514447_8

Kelder, S. H., Karp, G. G., Scruggs, P. W., & Brown, H. (2014). Setting the stage: Coordinated approaches to school health and physical education. *Journal of Teaching in Physical Education*, *33*(4), 440–448.

Kubesch, S., Walk, L., Spitzer, M., Kammer, T., Lainburg, A., Heim, R., & Hille, K. (2009). A 30-minute physical education program improves students' executive attention. *Mind, Brain, and Education*, *3*(4), 235-242.

Li, W., Gao, Z., Yin, Z., Xiang, P., Shen, B., & Kong, Q. (2016). Impact of national physical activity and health guidelines and documents on research on teaching K-12 physical education in USA. *Journal of Teaching in Physical Education*, *35*(2), 85–96.

Logan, G. D. (1997). Automaticity and reading: Perspectives from the instance theory of automatization. *Reading & Writing Quarterly,13*(2), 123-146. doi:10.1080/1057356970130203

Mahar, M. T., Murphy, S. K., Rowe, D. A., Golden, J., Shields, A. T., & Raedeke, T. D. (2006). Effects of a classroom-based program on physical activity and on-task behavior. *Medicine and Science in Sports and Exercise*, *38*(12), 2086-2094.

Manzo, L. G. (2005). Luis G. Manzo, Ph.D., Member-at-Large. *PsycEXTRA Dataset*. doi:10.1037/e538492009-008

McMullen, J., Kulinna, P., & Cothran, D. (2014). Physical activity opportunities during the school day: Classroom teachers' perceptions of using activity breaks in the classroom. *Journal of Teaching in Physical Education*, *33*(4), 511–527.

McMullen, J. M., van der Mars, H., & Jahn, J. A. (2014). Creating a before-school physical activity program: Pre-service physical educators' experiences and implications for PETE. *Journal of Teaching in Physical Education*, *33*(4), 449-466.

Millin, S. K., & Rinehart, S. D. (1999). Some of the benefits of readers theater participation for second-grade title I students. *Reading Research and Instruction, 39*(1), 71-88. doi:10.1080/19388079909558312

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex "frontal lobe" tasks: A latent variable analysis. *Cognitive Psychology*, *41*(1), 49–100.

Nathan, R. G., & Stanovich, K. E. (1991). The causes and consequences of differences in reading fluency. *Theory Into Practice, 30*(3), 176-184. doi:10.1080/00405849109543498

Naylor, P.-J., Macdonald, H. M., Zebedee, J. A., Reed, K. E., & McKay, H. A. (2006). Lessons learned from Action Schools! BC—an "active school" model to promote physical activity in elementary schools. *Journal of Science and Medicine in Sport*, *9*(5), 413–423.

Norman, D. & Shallice, T. (1986). Attention to action: Willed and automatic control of behavior. In R. J. Davidson, G. E. Scwartz, & D. Shapiro (Eds.), *Consciousness and Self-Regulation Volume 4* (pp. 1–14). New York, NY: Plenum Press.

Olson, L. (2007). DIBELS involved in 'Reading First' controversies. *Education Week*, *26*(35), 31–31.

Pangrazi, R. P., Beighle, A., Vehige, T., & Vack, C. (2003). Impact of Promoting Lifestyle Activity for Youth (PLAY) on children's physical activity. *Journal of School Health*, *73*(8), 317–321.

Parks, M., Solmon, M., & Lee, A. (2007). Understanding classroom teachers' perceptions of integrating physical activity: A collective efficacy perspective. *Journal of Research in Childhood Education*, *21*(3), 316–328.

Pate, R. R., Davis, M. G., Robinson, T. N., Stone, E. J., McKenzie, T. L., & Young, J. C. (2006). Promoting physical activity in children and youth a leadership role for schools: A scientific statement from the American Heart Association Council on Nutrition, Physical Activity, and Metabolism (Physical Activity Committee) in collaboration with the councils on Cardiovascular Disease in the Young and Cardiovascular Nursing. *Circulation*, *114*(11), 1214–1224.

Pearson. (2006). Professional assessments. Retrieved from https://www.pearsonassessments.com/professional-assessments.html

Pesce, C., Crova, C., Cereatti, L., Casella, R., & Bellucci, M. (2009). Physical activity and mental performance in preadolescents: Effects of acute exercise on free-recall memory. *Mental Health and Physical Activity*, *2*(1), 16-22.

Phillips, D. S., Hannon, J. C., & Castelli, D. (2014). The effect of vigorous-intensity physical activity on children's cognition. *Research Quarterly for Exercise and Sport*, *85*(1), A152.

Phillips, D., Hannon, J. C., & Castelli, D. M. (2015). Effects of vigorous intensity physical activity on mathematics test performance. *Journal of Teaching in Physical Education*, *34*(3), 346-362.

Pressley, M. (2002). Effective beginning reading instruction. *Journal of Literacy Research, 34*(2), 165-188. doi:10.1207/s15548430jlr3402_3

Pressley, M., Hilden, K., & Shankland, T. (2005). Cognitive strategies. In *Handbook of child psychology*. doi:10.1002/9780470147658.chpsy0212

Ramstetter, C. L., Murray, R., & Garner, A. S. (2010). The crucial role of recess in schools. *Journal of School Health*, *80*(11), 517-526.

Rasberry, C. N., Lee, S. M., Robin, L., Laris, B. A., Russell, L. A., Coyle, K. K., & Nihiser, A. J. (2011). The association between school-based physical activity, including physical education, and academic performance: A systematic review of the literature. *Preventive Medicine, 52*(1), S10-S20.

Rasinski, K. A., & Tourangeau, R. (1991). Psychological aspects of judgments about the economy. *Political Psychology,12*(1), 27-42. doi:10.2307/3791344

Rasinski, T. (2000). Review of "Preventing reading difficulties in young children" by Catherine E. Snow, M. Susan Burns, & Peg Griffin (eds.). *Written Language & Literacy, 3*(2), 281–285. doi:10.1075/wll.3.2.09ras

Rasinski, T. V. (2012). Why reading fluency should be hot! *The Reading Teacher, 65*(8), 516–522. doi:10.1002/trtr.01077

Rasinski, T. V., Padak, N., Linek, W., & Sturtevant, E. (1994). Effects of fluency development on urban second-grade readers. *Journal of Educational Research, 87*(3), 158-165. doi:10.1080/00220671.1994.9941237

Roberts, C. K., Freed, B., & McCarthy, W. J. (2010). Low aerobic fitness and obesity are associated with lower standardized test scores in children. *The Journal of Pediatrics*, *156*(5), 711-718.

Roberts, G., Good, R., & Corcoran, S. (2005). Story retell: A fluency-based indicator of reading comprehension. *School Psychology Quarterly, 20*(3), 304-317. doi:10.1521/scpq.2005.20.3.304

Sallis, J. F., & McKenzie, T. L. (1991). Physical education's role in public health. *Research Quarterly for Exercise and Sport*, *62*(2), 124-137.

Sallis, J. F., McKenzie, T. L., Beets, M. W., Beighle, A., Erwin, H. E., & Lee, S. M. (2012). Physical education's role in public health: Steps forward and backward over 20 years and HOPE for the future. *Research Quarterly for Exercise and Sport, 83*(2), 125-135.

Sallis, J. F., McKenzie, T. L., Kolody, B., Lewis, M., Marshall, S., & Rosengard, P. (1999). Effects of health-related physical education on academic achievement: Project SPARK. *Research Quarterly for Exercise and Sport*, *70*(2), 127-134.

Sallis, J. F., Simons-Morton, B. G., Stone, E. J., Corbin, C. B., Epstein, L. H., Faucette, N., . . . Rowland, T. W. (1992). Determinants of physical activity and interventions in youth. *Medicine & Science in Sports & Exercise, 24*(6), S248-S257.

Samuels, A. (2006). Allocation of resources in the NHS. *Reading Research Quarterly,74*(1), 30-33. doi:10.1258/rsmmlj.74.1.30

Stanovich, K. E. (1980). Toward an interactive-compensatory model of individual differences in the development of reading fluency. *Reading Research Quarterly, 16*(1), 32-71. doi:10.2307/747348

Stewart, J. A., Dennison, D. A., Kohl, H. W., & Doyle, J. A. (2004). Exercise level and energy expenditure in the TAKE 10!® in-class physical activity program. *Journal of School Health*, *74*(10), 397–400.

Strong, W. B., Malina, R. M., Blimkie, C. J., Daniels, S. R., Dishman, R. K., Gutin, B., . . . Trudeau, F. (2005). Evidence based physical activity for school-age youth. *The Journal of Pediatrics*, *146*(6), 732–737.

Sutherland, R., Campbell, E., Lubans, D. R., Morgan, P. J., Okely, A. D., Nathan, N., . . . Wiggers, J. (2016). "Physical Activity 4 Everyone" school-based intervention to prevent decline in adolescent physical activity levels: 12-month (mid-intervention) report on a cluster randomised trial. *British Journal of Sports Medicine*, *50*(8), 488–495.

Telama, R., Yang, X., Viikari, J., Välimäki, I., Wanne, O., & Raitakari, O. (2005). Physical activity from childhood to adulthood: A 21-year tracking study. *American Journal of Preventive Medicine*, *28*(3), 267-273.

Tindal, G., Marston, D., & Deno, S. (1982). Direct and frequent curriculum-based measurement: An alternative for educational decision making. *Special Services in the Schools, 2*(2-3), 5-27. doi:10.1300/j008v02n02_02

Tomkinson, G. R., Léger, L. A., Olds, T. S., & Cazorla, G. (2003). Secular trends in the performance of children and adolescents (1980–2000). *Sports Medicine*, *33*(4), 285-300.

Tomporowski, P. D., Lambourne, K., & Okumura, M. S. (2011). Physical activity interventions and children's mental function: An introduction and overview. *Preventive Medicine*, *52*(1), S3-S9.

Tremblay, M. S., LeBlanc, A. G., Kho, M. E., Saunders, T. J., Larouche, R., Colley, R. C., . . . Gorber, S. C. (2011). Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 98.

Trudeau, R., Laurencelle, T., & Shepard, S. (2004). Are health care professionals advising adults with arthritis to become more physically active? *Yearbook of Sports Medicine, 53*(2), 249-251. doi:10.1016/s0162-0908(08)70420-3

Trudeau, F., & Shephard, R. J. (2008). Physical education, school physical activity, school sports and academic performance. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1), 10.

Troiano, R. P., Berrigan, D., Dodd, K. W., Masse, L. C., Tilert, T., & McDowell, M. (2008). Physical activity in the United States measured by accelerometer. *Medicine and Science in Sports and Exercise*, *40*(1), 181-196.

Trost, S. G., Fees, B., & Dzewaltowski, D. (2008). Feasibility and efficacy of a “move and learn” physical activity curriculum in preschool children. *Journal of Physical Activity & Health*, *5*(1), 88-103.

Turner, L., & Chaloupka, F. J. (2016). Reach and implementation of physical activity breaks and active lessons in elementary school classrooms. *Health Education & Behavior*, *44*(3), 370-375.

United States Department of Health and Human Services. (2008). *Physical activity guidelines for Americans.* Washington, DC: Author.

United States Department of Health and Human Services. (1996). *Physical activity and health: A report of the Surgeon General.* Washington, DC: Author.

Van der Niet, A. G., Smith, J., Scherder, E. J., Oosterlaan, J., Hartman, E., & Visscher, C. (2015). Associations between daily physical activity and executive functioning in primary school-aged children. *Journal of Science and Medicine in Sport*, *18*(6), 673-677.

Wechsler, H., McKenna, M., Lee, S. M., & Dietz, W. H. (2004). Role of schools in preventing childhood obesity. *The State Education Standard, 5*(2), 4-12.

Welk, G. J., Jackson, A. W., Morrow, J. R., Jr., Haskell, W. H., Meredith, M. D., & Cooper, K. H. (2010). The association of health-related fitness with indicators of academic performance in Texas schools. *Research Quarterly for Exercise and Sport*, *81*(sup3), S16–S23.

Wilson, J. (2005). Assessing construct of DIBELS: Measurement invariance of DIBELS subscales, from kindergarten to the first grade. *Studies in Educational Evaluation, 40*(1), 12-17. doi:10.1016/j.stueduc.2013.11.008

Wolf, M., & Katzir-Cohen, T. (2001). Reading fluency and its intervention. *Scientific Studies of Reading, 5*(3), 211-239. doi:10.1207/s1532799xssr0503_2

World Health Organization. (2010). Global recommendations on physical activity for health. Retrieved from https://www.who.int/dietphysicalactivity/factsheet_recommendations/en/

Zutell, J., & Rasinski, T. V. (1991). This issue: Fluency in oral reading. *Theory into Practice, 30*(3), 142. doi:10.1080/00405849109543493