WEB-BASED ACTIVITY BREAKS:
IMPACTS ON ENERGY EXPENDITURE AND
TIME IN OFF-TASK BEHAVIOR IN ELEMENTARY SCHOOL CHILDREN

by

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I dedicate this work to my husband and children. Bill, I am grateful for the way you selflessly cared for our family in my frequent absence and distraction. Virginia, Henry, and Clay, thanks for being patient with me while I tried to be a good example of balance. Hopefully, you and other kids will get to be more physically active while at school as a result of this work.

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ABSTRACT

The purpose of study 1 was to characterize energy expenditure (EE) during academic subjects and activities during an elementary school day. Children in 2^{nd}-4^{th} grades (N = 33) wore the SenseWear Armband (SWA) for five school days to measure EE. Teachers' logs were compared to SWA data to extract information about EE throughout the day. Energy expenditure was also compared among grades. After controlling for body mass, grade level was not a significant predictor of average daily caloric expenditure, $F(2, 17.58) = 0.29$, $p = .75$, $\omega^2 = .05$. When comparing activities throughout the day, relative rates of EE differed significantly, *Wilks'* $F(7, 23) = 52.2$, $p = .00$, $\eta_p^2 = .94$, with PE and recess having higher EE than academic subjects. When academic subjects were compared (math, science, language arts), relative rate of EE was also significantly different, *Wilks'* $F(2, 30) = 4.31$, $p = .02$, $\eta_p^2 = .22$. For the full sample, relative rate EE was higher in science than in language arts.

The integration of web-based activity-breaks (AB) into the school day was explored in the investigation for study 2. Specifically, the impact of 3-minute, web-based AB on EE and time off-task behavior in 2^{nd} grade children was examined. Children (N = 38) in two classes wore a SWA for EE assessment and a modified version of the Behavioral Observation System in Schools was used to assess time off-task. Children participated twice in each of 4 conditions: control (CON), non-active breaks (NAB), one active break (1AB), and two active breaks (2AB). GoNoodle videos from the "Think About It" or "KooKoo Kangaroo" channels were used for the non-active and active breaks, respectively. Percent of time off-task was assessed prior to and following each condition. The number of AB significantly predicted EE, $F(2, 68.47) = 25.85$, $p < .001$ during the full instuctional period. The type of break (active or non-active) did not affect percent time off-task during the pre-break lesson, $F\ (2, 163.05) = 1.23$, $p = .30$, but NAB did reduce percent time off-task during the post-break lesson, $F\ (2, 167.26) = 13.67$, $p < .001$, compared to the control and NAB conditions. Intergrating web-based AB is an effective tool to increase EE and decrease time off-task in a 2^{nd} grade classroom.

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CHAPTER I

DISSERTATION INTRODUCTION

Physical activity (PA) offers multiple benefits to children's health including decreased adiposity, improved cardiovascular health, and increased musculoskeletal health. In addition to physical benefits, PA has positive effects on emotional and cognitive health and academic performance (Strong et al., 2005). Though a broad range of benefits exist, less than half of children in the United States accumulate the recommended 60 minutes of daily, moderate to vigorous PA (MVPA), 5 of 7 days per week (US Department of Health and Human Services, 2008; Triano et al., 2008).

While the proportion of children accumulating adequate PA is low, various settings offer opportunities to increase PA levels. The Department of Health and Human Services (2012) has highlighted five settings where opportunities exist to increase PA for children: school, preschool and childcare centers, community, family and home, and primary health care. There is a strong body of evidence that school-based PA interventions are effective (US Department of Health and Human Services, 2012) including enhanced physical education (PE), recess, and classroom activity breaks (AB). Mandated PE and classroom AB are strategies that produce the greatest impact on energy expenditure (EE) during the school day (Bassett et al., 2013). It has been suggested that children get at least 30 minutes of MVPA during the school day (Pate et al., 2006). However, elementary and secondary schools in the state of Tennessee are only required to accumulate 90 minutes of PA during the school week (House Bill 3750, 2006). As such, while strategies to increase PA exist, there are obstacles to putting these activities into practice.

Some common barriers to increasing PA during the school day are lack of resources and planning time, an unsupportive school climate, and lack of curriculum integration (Bartholomew & Jowers, 2011; Naylor et al., 2015). As with most attempts to increase PA, when designing school-based PA intervention, these barriers must be addressed. Because of the numerous studies on the health and academic benefits of PA and the great number of hours that children spend at school each week, overcoming the barriers to increase PA during the school day is a challenge worth pursuing. The additional benefit of improving academic performance provides further support for interventions aimed at increasing the PA of children during the school day.

Not only can AB interventions increase daily MVPA, but they may also enhance cognitive function and measures of academic performance (Kahn & Hillman, 2014; Lees & Hopkins, 2013). Academic performance can be measured by various outcomes and behaviors such as attention (Ma, Mare, & Gurd, 2015; Mahar et al., 2006) and concentration (Caterino & Polak,1999). While teachers are likely concerned about their students' health, a variable linked to their primary responsibility is time in off-task behaviors. Time off-task is the percent of time spent not focusing during instructional time and is negatively associated with better academic performance outcomes. If an intervention can be shown to decrease time off-task, classroom teachers may be more likely to implement the strategy.

The majority of studies using active lessons or ABs employ researcher-led interventions or "train-the-teacher" type programs. While both models have provided positive results, an AB program that requires no additional personnel and little training may also increase adoption rates by teachers. With increased access to web-based educational materials, a web-based program that leads AB in the classroom could be one viable solution. Options exist for web-based AB programs designed for primary school classrooms that are free of charge. GoNoodle is an example of this type of program (http://www.gonoodle.com). Though prior research strongly suggests AB in the classroom can increase daily EE in children and decrease time spent off-task, little is known about the effects of a web-based AB program on children's behaviors in school. Additional work must be done to quantitatively measure children's behaviors associated with classroom use of web-based AB products such as GoNoodle.

Given the significance of findings on AB programs on EE and time off-task, there is justification to investigate if web-based programs produce similar results. If GoNoodle is effective at increasing EE and decreasing time off-task, it is likely that more teachers would be willing to use AB in the classroom, given the relative ease of implementation.

Purpose

The purpose of the first study in this dissertation was to determine if there are instructional periods during the school day that have lower levels of EE. The first study was descriptive in nature and EE among different academic subjects (e.g., math, language arts, and science) was compared. Once this was determined, the purpose of the second study was to assess the effectiveness of GoNoodle as an AB on EE and time off-task during the academic subject deemed lowest in EE in study one.

Significance of Studies

Knowing which academic areas have low levels of EE can help identify times during the school day when an AB would be beneficial. Once an area of low EE is identified, it can be targeted for intervention using GoNoodle as an AB. Knowing if a GoNoodle AB is effective in enhancing EE and decreasing time off-task can help educators decide if this is a worthy product and strategy to be used in classrooms. If found to be effective, this could be helpful for teachers, principals, and policymakers when deciding which programs can be of the greatest benefit to the health and academic achievement of students.

CHAPTER II

REVIEW OF THE LITERATURE

This review begins with an overview of PA benefits for children. Next, the recommendations for children's PA are explained, followed by common ways in which PA can be increased for children. Current levels, followed by school day patterns of PA in children are described. A summary of relevant strategies to increase PA during the school day is then given in addition to barriers to using these strategies. The transition is made to an overview of studies related to the benefits of increased PA on different measures of academic achievement. Specifically, studies that describe the use of time in off-task behavior as a measure of academic achievement are highlighted. The section ends with an evaluation of AB as a PA intervention on time off-task. The need for AB which are easy for teachers to implement leads to a description of web-based products that are designed to use AB in the classroom. Finally, methods of measuring PA in children are described with an explanation for use of the SenseWear Armband (SWA). At the conclusion, justification for the study is made by pointing to the lack of convenient AB curricula for teachers.

Overview of the Benefits of Physical Activity for Children

Physical activity offers a myriad of benefits to the health status of children. As with adults, PA decreases adiposity, improves cardiovascular health, and increases musculoskeletal health. In addition to physical benefits, PA in youth can have positive effects for developing emotional and cognitive health and improving academic performance (Pirrie & Lodewyk, 2012; Strong et al., 2005). These benefits are highlighted below.

In both sexes, correlational studies show that children who participate in more PA have lower levels of adiposity (Strong et al., 2005). Additionally, experimental studies indicate children participating in exercise interventions have less of an increase in measures of adiposity than their non-exercising counterparts (Kriemler, Zahner, & Schindler, 2010; Simon et al., 2008). Exercise interventions also decrease total blood cholesterol levels in children (Robinson, Matheson, & Kraemer, 2010; Salcedo et al., 2010). A meta-analysis was conducted on the effects of obesity prevention programs (diet only, PA only, and combined programs) on blood pressure in children (Cai et al., 2014). Results from studies examining PA interventions only indicated a decrease in systolic (-1.07 mmHg) and diastolic (-1.28 mmHg) blood pressure ($p < .001$; Cai et al., 2014). For comparison, studies examining the effects of combined PA and diet programs showed an even greater reduction in systolic (-2.11 mmHg) and diastolic (-1.51 mmHg) blood pressure (Cai et al., 2014). The effect of PA on skeletal health (e.g., bone mineral density) has been positive in correlational, case, and retrospective studies (Strong et al., 2005). A recent 9-month experimental study examined the effects of 10-minute, high intensity bouts of exercise three times weekly during school hours (Nogueira, Weeks, & Beck, 2014). Results indicated the exercise group underwent a 4.9% increase in bone density measurement ($p = .046$) compared to only a 1.4% increase in the control group.

Dimensions of emotional health are positively affected by exercise as well. A 12-week PA and mindfulness intervention was implemented to determine its effects on stress response and mental health outcomes in 4^{th} and 5^{th} graders (Mendelson et al., 2010). Results indicated significant decreases in various subscales of the Responses to Stress Questionnaire including involuntary engagement (δ = 0.83), rumination (δ = 0.70), intrusive thoughts (δ = 0.51), and emotional arousal (δ = 0.64). Researchers explored a dose-response relationship between exercise (none, 20 minutes, or 40 minutes) and depression and measures of self-worth in overweight, sedentary children (Petty, Davis, Tkacz, Young-Hyman, & Waller, 2009). A significant linear dose-response relationship was found for symptoms of depression, global self-worth in White children, and physical appearance self-worth ($p < .05$).

The addition of PA during the school day can increase measures of cognitive function and academic achievement in children (Tomporowski, Lambourne, & Okumura, 2011). Although measurement of cognitive function and academic achievement varies, it is often indirectly assessed using standardized tests, grades, memory and concentration tests, executive function tests, or classroom behavior. Researchers generally assesses acute or chronic effects of PA on cognition. Studies on acute effects indicate that bouts of exercise ranging from 10-40 minutes can have positive effects on children's executive function and memory (Best, 2010; Budde, Voelcker-Rehage, Pietrabyk-Kendziorra, Ribeiro, & Tidow, 2008; Drollette, Shishido, Pontifex, & Hillman, 2012; Pesce, Crova, Cereatti, Casella, & Bellucci, 2009). School studies examining the effects of chronic exercise in children have also documented positive effects on measures of cognitive function and standardized achievement tests (Davis et al., 2011; Donnelly et al., 2009; Fisher et al., 2011; Kamijo et al., 2011).

A broad range of benefits of PA and exercise exist in children. Therefore, it is important that children participate in PA on a regular basis. However, the majority of children in the US are not achieving the recommended amount of daily PA.

Physical Activity Recommendations for Children

Despite the positive benefits associated with PA in children, less than half of children in the US accumulate the recommended 60 minutes of MVPA, 5 of 7 days per week (Department of Health and Human Services, 2008; Triano et al., 2008). Triano and colleagues (2008) measured PA recommendation adherence with accelerometers in 597 children. Results indicated that 42% of children (6-11 years) met the recommendation with more boys meeting the recommendation than girls (boys = 48%, girls = 35%). As age advances (12-15 years), the percent meeting the recommendation falls (boys = 12%, girls = 3%). Other studies also indicated a decline in daily MVPA as children advance in age. Objectively measured daily MVPA showed a significant inverse relationship with grade level across 1st through 12th grades (Trost et al., 2002). Additionally, in North Carolina, MVPA fell with each grade when observing youth in 4th through 8th grade (Moore, Beets, Morris, & Bolbe, 2014). International studies indicate even lower numbers for children's MVPA. Data from the international children's accelerometry database indicate among 5-17 year olds, only 9% of boys and 1.9% of girls accumulate 60 minutes of MVPA every day (Cooper et al., 2015). Although results from the preceding studies vary with age, location, and method of data collection, they all point to inadequate amounts of daily PA for children. While the proportion of children accumulating adequate PA is low, various settings offer opportunities to increase PA.

Opportunities to Increase Physical Activity in Children

The US Department of Health and Human Services (2012) has highlighted five settings where there are opportunities to increase PA for children: School, preschool and childcare centers, community, family and home, and primary health care. Various levels of evidence divided into the categories of sufficient, suggestive, insufficient, and evidence of no effect are assigned to each of these areas based on current research. The school setting is one of the leaders in sufficient evidence of where PA interventions can be effective (US Department of Health and Human Services, 2012). It has been suggested that children get at least 30 minutes of MVPA during the school day (Pate et al., 2006). However, children in elementary and secondary schools in the state of Tennessee are only required to accumulate 90 minutes of PA during the school week (TN H.R. 2148, 2016). Recent recommendations from the President's Council on Fitness, Sports, and Nutrition include strategies for incorporating multi-component, school-based interventions to increase daily PA during school hours, with enhanced PE and recess, AB, and before- and after-school programs as examples of successful practice (US Department of Health and Human Services, 2012). Because the majority of US children attend school 6-7 hours each day, the school day provides an ideal opportunity for increasing PA.

Physical Activity at School

There is evidence that strategies focusing on increasing PA during the school day are effective. A statement from the American Heart Association highlighted key practices for schools in increasing PA in children (Pate et al., 2006). Some of these practices for elementary children include accumulation of 30 minutes of MVPA per school day, at least 150 minutes per week in PE programs, delivering PE programs with at least 50% of class minutes in MVPA, at least 30 minutes of recess per day, and expansion of PA opportunities during the school day (e.g., classroom AB).

Bassett and colleagues (2013) studied which school-based policy or environmental change had the greatest impact on EE in children. Of the 65 studies included in the report, 53 included children in 6th grade or below. They concluded that mandated PE, classroom AB, and active commuting to school increased EE the most. Chen, Kim, and Gao (2014) studied the impact of PE on daily MVPA in 6th-grade students and found significant, positive associations between minutes in PE and daily minutes of MVPA. These results were significant despite the fact that only 42% of PE minutes were in MVPA (50% is the benchmark for "high quality" PE). In a review of studies examining physically active lessons to increase PA, six of seven studies found that physically active lessons improved PA levels in children (Norris, Shelton, Dunsmuir, Duke-Williams & Stamatakis, 2015).

While single strategies of increasing PA in schools are beneficial, Carlson and colleagues (2013) found that elementary schools with four out of five practices increased MVPA per day by 20 minutes more than schools with only one of the key practices. The practices they examined were having a PE teacher, providing ≥ 100 minutes per week of PE, having recess supervised by a non-classroom teacher, providing a ≥ 20 minute period of recess, and having ≤ 75 students/teacher in recess at a time. The most important practices that increased daily MVPA were having a PE teacher and providing ≥ 100 minutes per week of PE.

State- and district-wide policies mandating practices to increase PA during the school day can increase daily PA in schools. A survey on PE and recess practices determined that mandating PE and recess effectively increased PA opportunities for children during the school day (Slater, Nicholson, Chriqui, Turner, & Chaloupka, 2011). This survey on US public elementary schools indicated the odds of states or districts having at least 150 minutes/week of PE and 20 minutes of daily recess were greater if they were in states or districts having a law or policy requiring PE. In Nebraska, compliance with a recommendation of 20-minutes per day increased PA outside of PE was observed (Holt, Bartee, & Heelan, 2013). Of the observed classrooms, 40% in September and 4% in February were adhering to the recommendation of a 20-minute/day increase in PA on all five school days each week. However, a higher percentage of classrooms (February = 73%, September = 46%) were adhering to the recommendation at least three days per week. The activities that were most beneficial in helping teachers meet the extra 20 minutes of PA were curriculum-based classroom activities and walk-run activities.

Increasing PA during the school day can be done using an array of different approaches. Whereas the types of activities can vary, it seems any are more likely to take place if mandated by school districts or state regulation. Whether mandated or not, obstacles to putting these activities into practice are present and must be addressed.

Barriers to Increasing PA in Schools

Despite potential benefits, barriers to implementing strategies to increase PA during the school day exist. Naylor and colleagues (2015) identified common barriers to implementation in an international review of school-based PA interventions. Elementary aged-children were examined in the majority of studies (60%) for the review, but middle school aged (13%) and high school aged-students (27%) were also included. Time constraints within the classroom emerged as the primary hindrance to successful implementation in 23 of 29 studies meeting the review criteria. Other common barriers in the review included resource availability/quality and supportive school climate. Supportive school climate could be related to whether or not resources are available and time is encouraged to be used on PA in the school day. Behavioral medicine literature supports the notion that while all teachers experience time barriers, those who value the program (e.g., PA intervention) will implement it despite the perceived barrier (Naylor et al., 2015).

When developing the Texas I-CAN! (*I*nitiatives for *C*hildren's *A*ctivity and *N*utrition) method of active lessons, researchers learned of barriers to implementation through initial attempts to integrate the program into the school day (Bartholomew & Jowers, 2011). Their first effort in using Texas I-CAN! was made to train teachers in modifying lesson plans to incorporate PA during class time. After the initial pilot using Texas I-CAN!, follow-up revealed that implementation among teachers was low (<25%)

because of lack of planning time and available resources (model lesson plans/equipment). Therefore, another pilot used the Take 10 curriculum (Stewart, Dennison, Kohl, & Doyle, 2004), which has been successfully implemented in elementary schools. Take 10 uses 10-minute bouts of repetitive high-intensity activity while reinforcing previously learned academic material. After attempts with Take 10, focus groups indicated teachers regarded these lessons as having insufficient curriculum integration. Thus, with combined efforts of researchers and teachers, an updated Texas I-CAN curriculum was developed to meet teachers' needs and was used successfully in subsequent research (Bartholomew & Jowers, 2011).

As with most attempts to increase PA, when designing school-based PA intervention there are barriers that need to be overcome. Keeping in mind the numerous studies on the health benefits of PA and the great number of hours that children spend at school each week, overcoming these barriers to increase PA during the school day is a challenge worth pursuing. The additional benefit of improving academic performance provides further support for interventions aimed at increasing PA of children during the school day.

The Impact of Increased PA on Measures of Academic Performance

Not only can PA interventions increase daily MVPA, they may also enhance cognitive function and measures of academic performance (Kahn & Hillman, 2014; Lees & Hopkins, 2013). Lees and Hopkins (2013) reviewed eight randomized control trials in elementary-aged children and found positive benefits in academic achievement, cognition, behavior, and psychosocial functioning (e.g., depression, anxiety, and selfesteem) from school-based aerobic PA interventions with children. Interventions ranged from 10-15 minutes daily to 60 minutes of daily moderate intensity aerobic PA. All showed at least minimal improvement on measures of cognition and psychosocial health while none showed a negative impact on these measures. No negative impact was shown on cognition and psychosocial health even when time was taken from the teaching curriculum to participate in aerobic PA (Lees & Hopkins, 2013).

In another review of observational and intervention studies, Singh and colleagues (2012) found a significant positive relationship between PA and academic achievement. However, the authors only deemed 2 of the 10 included studies high-quality, therefore calling for more dose-response studies on the relationship between physical activity and academic performance. As an example, the Physical Activity Across the Curriculum (PAAC) program was designed to integrate PA within the school day using moderate- to vigorous-intensity physically active lessons based on state standard specific curricula (Donnelly et al., 2009). Teachers from 14 elementary schools (*n* = 814 students) in Kansas attended a 6-hour training in order to implement 90 minutes of PAAC lessons per week during the school day. These schools were randomly assigned as experimental schools to compare with 10 control schools (*n* = 713 students). Students were in 2nd and 3rd grades at the beginning of implementation and progressed to 4th and 5th grades by the end. Intensity was monitored using direct observation, but a sub-sample of participants from each school wore accelerometers for 4 days during the spring semester, each year of program assessment. Academic achievement was assessed using a standardized achievement test for reading, writing, mathematics, and oral language skills. In a 3-year study to assess the effectiveness of the PAAC program, intervention classes showed significant increases ($p < .01$) over control classes on achievement tests in reading, mathematics, and spelling (Donnelly et al., 2009).

More recently, Ma, Mare, and Gurd (2015) studied the effectiveness of a 4-minute researcher-led AB compared to a non-active kinesiology lesson on selective attention in 9-11-year old children. Selective attention was measured using the pen and paper d2 assessment of individual attention and concentration related to academic performance (Brickenkamp, 2002). The researchers observed 1% fewer errors on the d2 test of selective attention after participation in the active lesson ($p < .01$, $\delta = 0.23$).

Howie, Schatz, and Pate (2015) studied a dose-response relationship between classroom AB and executive function and math performance in 4^{th} and 5^{th} grade students. Examples of executive functions are working memory, cognitive flexibility, and inhibition and have been shown to respond positively to exercise in children (Miyake et al., 2000; Tomporoski et al., 2011). Though no improvement was noted in executive function tasks, math test scores were higher after 10- and 20-minute AB compared to a 10-minute sedentary break ($p = .04$, $\delta = 0.24$; $p = .03$, $\delta = 0.27$). Further, no differences in executive function tasks or math scores were observed between the 10- and 20-minute AB. Caterino and Polak (1999) investigated the acute effect of increased PA on concentration. A 15-minute break of stretching and aerobic walking was compared to an equivalent sedentary break in the classroom in 2^{nd}-4^{th} grade children. Both groups took the Woodcock-Johnson Test of Concentration immediately after the respective breaks, and 4^{th} graders with the PA break had higher mean concentration levels than the sedentary break group (PA = 20.88 ± 4.68, sedentary = 18.00 ± 3.43, p = .05). In 2nd and 3rd graders, the physically active break did not increase concentration levels, but they remained the same. This indicates that even if a PA break does not increase concentration levels, it is not detrimental to concentration levels.

Academic performance can be measured using various outcomes (e.g., test scores) and behaviors such as attention and concentration. Many of these measures are positively affected by incorporating AB into the school day. Another behavior that is positively impacted by increasing PA in schools is time spent in off-task behavior.

Increased PA and Time Off-Task

While teachers are likely concerned about their students' health, a variable linked to their primary responsibility is time off-task. Long periods of instruction without a break are counterproductive to learning (Pellegrini & Davis, 1993) and increase fidgety and off-task behaviors (Jarrett et al., 1998). A review examining the effects of short bouts of PA (e.g., recess, active lessons in the classroom) on time on-task found small to moderate effects (δ = 0.13 to 0.60; Mahar, 2011). This indicates brief PA bouts during the school day can have a positive effect on time spent in off-task behavior.

A classroom based activity program called Energizers was developed and implemented in the state of North Carolina (Mahar et al., 2006). Energizers are 10-minute content-based PA lessons for kindergarten through 4th grade classrooms that are based on grade appropriate content and use no materials. Teachers initially attended a 45-minute training session on how to use Energizers, then incorporated them once per day for 12 weeks. The effects of the program were evaluated in 243 students and the intervention group took significantly more steps throughout the school day compared to a control group. Additionally, percent of time in on-task behavior for the intervention group was increased significantly ($p < .02$) by 8% from pre- to post-activity break (70.9% to 79.2%). The students lowest in on-task behavior improved percent of time in on-task behavior from 46.1% pre-Energizers activities to 66.0% post-Energizers activities ($p < .05$, $\delta = 2.20$).

Bartholowmew and Jowers (2011) studied the effects of physically active academic lessons on daily in-school step count and time on-task. The Texas I-CAN! program was designed to incorporate PA into information with PA games and drill and practice of factual information through PA games. A pilot study assessed the Texas I-CAN! protocol with 22 teachers (grades K-4) in one school being trained and given sample lessons that aligned with the Texas Essential Knowledge and Skills to use for 4 weeks. Pedometers were used during one week to compare average step counts on the 2 days of active lessons versus 2 days of non-active lessons. They found significantly increased step count (approximately 1,000 additional steps) on the active lesson days versus the non-active lesson days. In response to the pilot study, 8 schools were recruited to compare the effects of Texas I-CAN! lessons (25 teachers) to sedentary lessons (22 teachers) as a control. Teachers in the experimental active lesson group were asked to implement Texas I-CAN! 4 of 5 school days. Pedometer counts indicated the group participating in Texas I-CAN! increased daily PA by 300 steps compared to their baseline assessment while the control group decreased PA by 300 steps compared to their baseline assessment. Though the difference in step counts between groups was significant, the daily increase in step count was not as high as that found in the 1-school pilot study. Additionally, in the 8-school study, percent of time spent on-task increased significantly from 86% pre-active lesson to 89% post-active lesson. In the inactive lesson group, percent of time spent on-task decreased from 83% pre-inactive lesson to 72% post-inactive lesson. It is possible that better teacher training and involvement in lesson development led to better results in the pilot than the larger scale Texas I-CAN! study. However, results from the Energizers and Texas I-CAN! studies indicate active lessons can have significant positive effects on percent of time spent in on-task behavior in addition to increasing PA during the school day.

Grieco, Jowers, and Bartholomew (2009) examined the effects of the Texas I-CAN! program on time on-task with body mass index (BMI) as an additional factor with 3rd grade children. The 10- to 15-minute moderate to vigorous physically active lessons were used for math, language arts, science, social studies, or health. Teachers were given an 8-hour training at the beginning of the school year and asked to use the program at least once per day on 4 out of 5 days each week. Time on-task was observed on non-physical education days during instructional time (1:15 – 2:15 P. M. range) for 15 minutes before and after the active or active lesson. In the control group with an inactive lesson, children in all BMI categories significantly decreased their percent of time in on-task behavior after the inactive lesson ($p < .05$). However, percent of time on-task remained constant in all BMI categories with the use of a PA Texas I-CAN! lesson. Similar to Caterino and Polak's study on AB and concentration (1999), this indicates that even if percent of time in on-task behavior does not increase, a benefit of active lessons can be preventing a decrease in time on-task. Remaining at a consistent level of on-task behavior over extended lesson times can be beneficial to concept retention.

More recently, Carlson (2015) and colleagues observed the effects of a grant funded, district-wide initiative to encourage teacher-led AB across 7 California school districts. In 6 of the districts, 97 classrooms participated in the study to determine the effect of daily PA breaks on classroom behavior. Each district developed their own plan for at least 2 schools to help teachers implement a once daily 10-minute AB using an evidence based program in 1st-6th grade classrooms. Assessment of PA was done using accelerometers one week each in the fall and spring, while classroom behavior was assessed by teachers' completion of an adapted Classroom Behavior and Assets Scale (Lee, Shaftel, Neaderhiser, & Oeth, 2009). Minutes/day of AB were positively associated with student MVPA in all grades ($p = .016$). Implementation of AB in classrooms was negatively associated with lack of effort ($p = .042$) and student MVPA was negatively associated with being off-task ($p = .042$). Lack of effort and off-task behavior were assessed on the class as a whole by their respective teacher.

For all BMI categories, active curriculum-based lessons during the school day are beneficial for increasing PA levels and time in on-task behavior. The Energizers and Texas I-CAN! programs used approximately 10-minute PA bouts designed by researchers with the input of classroom teachers, physical education teachers, and state curriculum standards. While incorporating PA bouts in this format is beneficial for time spent in on-task behavior, different AB durations and delivery format have shown positive results as well. Other researchers have examined the effect of AB that are shorter in duration and are not curriculum-based (Ma, Mare, & Gurd, 2014; Ma, Mare, & Gurd, 2015).

Short Duration, Non-curriculum Based Activity Breaks and Time Off-Task

Emerging research supports the use of short AB in the classroom for improved time off-task and classroom behavior. The effect of a 4-minute AB compared to a sedentary break on percent of time in off-task behaviors was examined in 2nd and 4th graders (Ma, Mare, & Gurd, 2014). FUNtervals are activities designed for the classroom that require no equipment, are high intensity intervals, and can be implemented in 4 minutes. A FUNterval consists of 20 seconds of high intensity whole-body movement followed by 10 seconds of rest, then repeated 8 times. Second grade verbal (i.e., talking to a classmate, speaking when not called upon), passive (i.e., gazing off, not making eye contact to the speaker, head down on the table), and motor (i.e., fidgeting, drawing, restlessness) off-task behaviors decreased significantly more (by 3%, $p < .05$, $\delta = 0.45$; 9%, $p < .01$, $\delta = 0.74$; and 15%, $p < .01$, $\delta = 1.076$, respectively) when participating in the AB compared to the non-active break. Additionally, the AB was significantly more beneficial in reducing passive ($p < .05$, $\delta = 0.31$) and motor ($p < .01$, $\delta = 0.48$) off-task behaviors in 4th graders.

The majority of studies using active lessons or AB employ researcher-led interventions or “train-the-teacher” type programs. While both models have provided positive results, an AB program that requires no additional personnel and little training may increase adoption rates by teachers. In a study evaluating the effectiveness of an AB intervention in Texas, it was reported that only 43.2% of teachers used the AB weekly, even when given training (Delk, Springer, Kelder, & Grayless, 2014). Finding ways to encourage teacher adoption of physically active lessons or AB in the classroom is important to the success of these interventions. With increased access to web-based educational materials, a web-based program that leads AB in the classroom could be one viable solution. Web-based programs reduce the need for teacher training in AB curriculum and are relatively easy to use with Internet access. Options exist for web-based AB programs designed for primary school classrooms that are free of charge. GoNoodle is an example of this type of program (http://www.gonoodle.com).

Web-Based Activity Breaks in the Classroom

GoNoodle is a web-based interactive platform designed for implementing AB in the classroom. The content is designated for grades K-5 and duration ranges from 1-25 minutes with different "channels" for various desired effects (e.g., calming, energizing, stretching, and coordination). GoNoodle can be used in any classroom with Internet access and has been widely adopted by teachers in the state of Tennessee. All Tennessee K-12 schools have free access to GoNoodle and all public schools in the state currently have free access to GoNoodle Plus, which matches active lessons with state-aligned core standards. Coordinated School Health of Tennessee (a government funded program of the state Health Department) recommends use of GoNoodle and has information about the program on their Nashville division website. Kindergarten through 2nd grade make up the largest user population for GoNoodle users and teachers use it an average of 10 accumulated minutes each day (A. Briggs, personal communication, September 2, 2015).

Prior research strongly suggests AB in the classroom can increase daily energy expenditure in children and decrease time spent off-task. However, little is known about the effects of a web-based AB program on children's behaviors in school. To know statistics on program usage does not sufficiently give information on whether or not the intended purpose is being achieved. Therefore, additional work must be done to quantitatively measure children's behaviors associated with classroom use of web-based AB products such as GoNoodle.

Measurement of EE in Children

The ability to collect valid information about children's patterns and quantity of movement in free-living conditions is an evolving science. Frequently used techniques include direct observation, accelerometry, and self report questionnaires (Stookey, Mealey, & Shaughnessy, 2011). Popular methods used for direct observation of childrens' PA are the System for Observting Play and Leisure Activities (SOPLAY; Saint-Maurice, Welk, Ihmels, & Krapfl, 2011) for recreation and the System for Observing Fitness Instruction Time (SOFIT; Honas et al., 2008) for fitness. In a review of PA assessment in youth, accelerometers combined with physiological measures (i.e., heart rate) were stated as the preferred method of data collection because of their ease of use and relative low cost (Corder, Ekelund, Steele, Wareham, & Brage, 2008).

While accelerometers are a popular objective PA assessment method, they may not be accurate in capturing lower intensity activities of daily living (Kozey-Keadle, Libertine, Lyden, Staudenmayer, & Freedson, 2011). The SenseWear Mini Armband (SWA) is an accelerometry-based technology that uses additional parameters (i.e., galvanic skin response, skin temperature, near body ambient temperature, and heat flux) to track total and active energy expenditure (EE), metabolic equivalents (METS), step counts, and PA intensity and duration in free-living conditions. The SWA has been used with children in laboratory (Lee, Kim, Bai, Gaesser, & Welk, 2014) and educational settings (Benden, Mancuso, Hongwei, & Pickens, 2011; Benden, Zhao, Jeffrey, Wendel, & Blake, 2014; Chen et al., 2014).

A limitation of some accelerometers is the ability to detect changes in movement pattern at lower ranges of intensity (Kozey-Keadle et al., 2011). Because many school activities happen within lower ranges, it is important for an EE monitor capture the full spectrum of movement intensity. In a pilot study, Benden and colleagues (2011) used the SWA to detect subtle changes in EE between working at sitting and standing desks in 7-10 year old children ($N = 21$). Paired comparisons indicated a significant difference in EE ($p < .0001$) between those sitting at a traditional desk and those standing at a height-adjusted standing desk with a foot rest for 30 minutes (Benden et al., 2011). This indicates there may be some advantage to using the SWA in studies where children are moving at lower intensity levels. After piloted, the SWA was used to determine if stand-biased desks were effective at increasing EE throughout the school day (Benden et al., 2014). Stand-biased desks can alter between sitting and standing and give children the option of which position to choose during a lesson. Though results indicated that stand-biased desks significantly increased EE over seated desks, of relevance to this topic was that SWAs were successfully used in 24 classrooms of 2nd-4th graders. Additionally, the SWA was also used to test the effect of PE on time in MVPA and sedentary time during a

7-day or 14-day time period in 6th graders (Chen et al., 2014). Participants wore the SWA for at least 10 hours each day with total wear-time including minutes within and outside of the school day. These examples suggest that the SWA can be an effective tool to measure EE in a school setting. When used for multiple days during school time, the SWA was worn by students for 5 days (Benden et al., 2014; Chen et al., 2014).

Though multiple devices have been used to measure children's EE (e.g., various pedometers and accelerometers), a reliable and valid tool for low- to moderate-intensity PA is the SWA. In addition, studies indicate the SWA is appropriate for use in children as young as 7-years old, the youngest likely age for a 2nd grader (Lee et al., 2014). Because the SWA can indeed objectively measure PA and delineate between low intensity activities in the classroom, it seems a likely tool to use for examining the effects of a web-based AB program during the school day.

Conclusions

Adequate amounts of PA have health and academic benefits for children. Given that children should participate in 60 minutes of PA each day and 30 of these should come during school hours, schools seem a likely place for PA interventions. Increased PA can come from recess or PE, but AB in the classroom have been established as a highly effective PA intervention in schools. Not only can AB increase daily PA, but produce academic benefits as well. One behavior associated with academic achievement is decreased time off-task. Studies indicate that AB in the classroom increase EE and decrease time spent in off-task behavior. Because research on AB has used teacher or researcher led interventions, effectiveness of web-based AB programs on EE and time off-task in elementary classrooms are needed. Therefore, the purpose of these studies were to describe EE patterns during an elementary school day. Also, effects of 3-minute AB using the GoNoodle online platform on EE and time off-task in 2^{nd} graders were assessed. In addition, a dose response relationship will be explored to determine how many daily activities in GoNoodle are needed to maximize results.

CHAPTER III

SCHOOL DAY ENERGY EXPENDITURE

Introduction

Despite its role in childhood health, the level of health-enhancing physical activity (PA) among children remains stagnant while time spent in sedentary behaviors has increased (Biddle, Gorely, & Stensel, 2004). Only 42% of children in the United States (US) currently accumulate the recommended amount of moderate to vigorous physical activity (MVPA) 5 out of 7 days per week (Triano et al., 2008). Further, this percentage declines significantly as children move into the adolescent years.

Because the majority of US children attend school 6-7 hours each day, the school day provides an ideal opportunity for increasing PA. Recent recommendations from the President's Council on Fitness, Sports, and Nutrition include strategies for incorporating multi-component, school-based interventions to increase daily PA during school hours (US Department of Health and Human Services, 2012). Examples of these recommendations include regularly scheduled physical education classes, daily recess with adequate game equipment, classroom activity breaks, and modified school environments. The Society of Health and Physical Educators recommends at least 150 minutes per week in physical education class and at least 50% of these minutes achieving moderate to vigorous PA (National Association for Sport and Physical Education, 2016). However, only 25% of states require this physical education recommendation (National

Association for Sport and Physical Education, 2016). In order to conduct school based PA programs, it is important to determine likely opportunities to increase PA during the school day. While physical education class and recess are traditionally thought to provide necessary outlets for movement, additional opportunities exist in smaller portions of time during traditionally sedentary lessons. To incorporate additional PA into the school day, it is important to document children's PA patterns and energy expenditure (EE) during different instructional times.

Physical activity has been monitored in children using various data collection techniques. Frequently used techniques include direct observation, accelerometry, and self report questionnaires (Stookey, Mealey, & Shaughnessy, 2011). While accelerometers are a popular objective PA assessment method, they may not be accurate in capturing lower intensity activities of daily living (Kozey-Keadle, Libertine, Lyden, Staudenmayer, & Freedson, 2011). The SenseWear Mini Armband (SWA) is an accelerometry based technology that uses additional parameters (i.e., galvanic skin response, skin temperature, near body ambient temperature, and heat flux) to track total and active EE, metabolic equivalents (METS), step counts, and PA intensity and duration in free-living conditions. The SWA has been used with children in laboratory (Benden, Mancuso, Hongweizhao, & Pickens, 2011) and educational settings (Benden, Zhao, Jeffrey, Wendel, & Blake, 2014; Senlin, Youngwon, & Zan, 2014).

The ability to monitor student EE throughout a typical school day in the U.S. could provide valuable information for administrators, teachers, and physical educators alike. Therefore, the purpose of this study was to describe EE during various academic subjects and activities during an elementary school day. Comparisons of school day EE were also made among grades.

Methods

Participants

Intact classes (*N* = 3) in a private, primary school in the southeastern part of the US were randomly selected by the school principal to participate in the study. All children in each of the randomly selected 2nd- 4th grade classes were eligible to participate, with a total of 9 students in 2nd grade, 15 students in 3rd grade, and 9 students in 4th grade volunteering, for a sample of 33 students. Ethical approval was received by the Institutional Review Board (IRB) at the sponsoring university. Informed consent was provided by each parent or guardian, and assent forms were signed by all students involved prior to data collection.

Instruments

SenseWear™ Mini Armband

The SWA (Body Media Inc., Pittsburg PA) was used to monitor PA throughout the school day. The SWA, which has been validated in children (Calabró, Stewart, & Welk, 2013; Lee, Kim, Bai, Gaesser, & Welk, 2014), is a multi-sensor, portable activity monitor that is worn on the triceps of the upper left arm. It measures EE by monitoring motion and steps (via accelerometer), galvanic skin response, skin temperature, and heat flux. The SWA Velcro strap in size small or medium was used to secure the monitor to each child's arm.

Procedures

Following university Institutional Review Board approval, information letters were sent home to children in one 2nd, one 3rd, and one 4th grade class. The first day of data collection for each grade was on a Monday. As children arrived at school, they signed assent forms and were fitted with a SWA on the triceps of their left arm. Their arms were inspected to ensure they were free of lotions and the strap was comfortable for the children. After all participating children were fitted, instructions were provided regarding the SWA including a reminder to let the teacher know if the SWA caused any itching or irritation. The SWA was worn throughout the school day (6.5 - 7 hours) and taken off by the researcher before each child left for the day.

The same procedures were followed each day for five consecutive days, Monday through Friday. Each day the armbands were put on the children by 8:30 a.m. Depending on classroom schedules, armbands were taken off between 2:35 p.m. and 2:55 p.m. each afternoon before dismissal. The SWAs were randomized so that each child received a different device each day. Data from the SWA were downloaded (BodyMedia software version 8.1, Pittsburg, PA) and the devices were cleared following each school day. Data collection was completed during a three-week period. During week one the SWA was worn by 2nd graders, week two by 3rd graders, and week three by 4th graders. During each school day, the teacher filled out a form describing the curricular schedule for the day and indicating if there were any problems with the use of the SWA. The schedule included information regarding time blocks for each subject, the subjects for the day, location of subject areas (e.g., classroom, gym, cafeteria, art room), and active transport time.

Height, body mass, handedness, and birth date for each participant were obtained by the primary investigator during physical education class the week of data collection for proper algorithm analysis. Height and body mass were each measured twice with the average of the two measurements used in data analysis. Height in centimeters was measured using a portable stadiometer (Seca # 214, Birmingham, UK). A Seca (# 899, Hamburg, Germany) scale was used to measure body mass in kilograms for each child. Students wore their school uniform with shoes off during all measurements.

Data Analysis

Average school day EE was compared among 2^{nd} grade (n = 9), 3^{rd} grade (n = 15), and 4^{th} grade (n = 9) classes. Welch ANOVAs were used to indicate whether grade level (2^{nd}, 3^{rd}, or 4^{th}) was a significant predictor of average daily caloric expenditure and relative average daily caloric expenditure. Daily EE (kilocalories per 360 minutes) was downloaded from the SWA after each school day for each student throughout the week. Energy expenditure was recorded for the same six hours of the school day for each student. If a student was not present for the full six hours, EE for that day was not included in the weekly average. Data were used for daily EE if the child had six hours of wear time four out of five days of the respective week. The child also needed to have an SWA on-body time of at least 95% throughout the six hours. If a child removed the SWA throughout the day (wear time of < 95%), his or her daily EE was not included.

Percent of total daily minutes in MVPA was calculated. Also during physical education class, percent of minutes in MVPA out of total minutes was calculated.

Rate of EE (kcal/kg/min) within specific time blocks was compared for analysis using mathematics, language arts, science, music, art, physical education, recess, and lunch. All time blocks were compared using a one-way repeated measures ANOVA. One-minute epochs were downloaded and analyzed for each time block. The teacher's daily logs were used to decipher when and how long students were in each time block. Total kilocalories expended, student body mass, and total minutes for each time block were used to calculate the rate of EE (kcal/kg/min) for each time block. Transport time between rooms was not included for any of the time blocks. All grades (2nd, 3rd, and 4th) were combined for between time block analysis. As an example, for students in all grades (N = 33), the EE in math was compared to the average rate of EE in science. Pairwise comparisons for time blocks were conducted using the Bonferonni procedure.

Data comparing rates of EE for different time blocks were used for each child present during the specified block of learning time. A few children arrived to school late or left early, and their total daily EE were not used in the analysis among grades. Therefore, a child's daily EE may not be included in total EE analysis, while their EE rates for some time blocks were included.

Results

Of the 50 possible students in the selected classrooms, 33 parents and/or guardians (66%) returned the informed consent form permitting their child (M age = 9.0 ± 1.0 years) to participate in the study. Descriptive statistics for participant characteristics are shown in Table 1. Of the 33 participants, 15 were male and 18 were female. The average wear time for the SWA across five days for all students was 358.6 minutes of the 360.0 minutes available (99.6%). The average percentage of minutes spent in MVPA (105 minutes) throughout the school day was 29.2%.

Descriptive statistics for average daily EE rates are shown in Table 2. Grade level (2^{nd}, 3^{rd}, or 4^{th}) was a significant predictor of absolute average daily caloric expenditure, $F(2, 17.70) = 3.60$, $p = .049$, $\omega^2 = .14$. Children in 4^{th} grade ($M = 1.88$ kcal/min) had higher EE than those in 3^{rd} grade ($M = 1.53$ kcal/min). However, after controlling for body mass, grade level was not a significant predictor of average daily caloric expenditure, $F(2, 17.58) = .29$, $p = .75$, $\omega^2 = .05$.

Descriptive statistics for EE rates among subject areas are shown in Table 3. When all 8 time blocks were compared, relative EE differed by time block, *Wilks' F*(7, 23) = 52.2, $p < .001$, $\eta_p^2 = .94$. Recess and PE had significantly higher EE than all other time blocks, but did not differ from one another. When the three academic areas (science, math, language arts) were compared, relative EE was also significantly different *Wilks' F*(2, 30) = 4.31, $p = .02$, $\eta_p^2 = .22$. Relative EE was higher in science than in language arts.

Discussion

The present study was designed to describe children's PA patterns during a typical school day. Whether it is because of longer learning periods or decreased interest in PA, children reduce time spent in MVPA as they advance in age (Trost et al., 2002). In the current study PA was assessed with the SWA. This allowed EE assessment instead

Table 1

Participant Characteristics

Variable	Grade Second (n = 9)	 Third (n = 15)	 Fourth (n = 9)	Full sample (N = 33)
Age (years)	7.9	9.1	10.1	9.0
Body mass (kg)	32.1	30.9	40.8	33.9
Height (cm)	135.8	134.2	147.6	138.3
BMI (kg/m^2)	17.4	17.1	18.5	17.6
Sex (M/F)	3/6	8/7	4/5	15/18

Table 2

Average Daily Energy Expenditure Rates by Grade Level

	Grade			
Rate of EE	Second (n = 9)	Third (n = 15)	Fourth (n = 9)	Full sample (N = 33)
Absolute rate (kcal/min)	1.59 ± 0.25	1.53 ± 0.30	1.88 ± 0.11*	1.64 ± 0.32
Relative rate (kcal/kg/min)	0.05 ± 0.01	0.05 ± 0.01	0.05 ± 0.01	0.05 ± 0.01

Note. EE = energy expenditure; values represent mean ± standard deviation;
*Significantly greater than 3rd grade at α = .05.

Table 3

Energy Expenditure in Different School Subjects

	Average daily caloric expenditure		
Academic area	Kcal/min	Kcal/kg/min	*N*
Math	1.44 ± 0.38	0.04 ± 0.01	32
Science	1.65 ± 0.62	0.05 ± 0.02**	32
Language arts	1.38 ± 0.23	0.04 ± 0.01	32
PE	2.55 ± 0.46	0.08 ± 0.02*	30
Art	1.18 ± 0.18	0.04 ± 0.01	30
Music	2.06 ± 0.24	0.05 ± 0.01	30
Recess	1.38 ± 0.30	0.08 ± 0.02*	30
Lunch	1.34 ± 0.30	0.04 ± 0.01	30

Note. PE = physical education; *Significantly greater than other 6 time blocks at α = .05 when comparing all 8 time blocks; ** Significantly different from language arts at α = .05 when comparting 3 academic subjects.

of using minutes of PA as a measure of EE. A difference in EE throughout the school day existed among grades. Fourth graders expended more energy than 3rd graders, while no difference existed between 2nd graders and 3rd or 4th graders, respectively. However, when controlling for body mass, EE was similar across grades. The 4th graders had the highest mean body mass and the 3rd graders had the lowest mean body mass.

Many opportunities exist for PA while children are in school. Current recommendations are for children to perform at least 30 minutes of MVPA during school hours (Pate et al., 2006). Students in the present study spent an average of 109 school day minutes in MVPA with 100% meeting the recommendation of at least 30 minutes per school day. This is in contrast to results from the ENERGY project that measured school day MVPA in European children (VanStralen et al., 2014). Van Stralen et al. reported that only 7% of 1,025 school children in their sample accumulated 30 minutes of MVPA (2014). Also, studies in the United Kingdom and Canada have shown similar low numbers with only 9% and 16% of the school day, respectively in MVPA (Nettleforld, Mckay, & Warburton, 2011; vanSluijs, Jones, & Jones, 2011). However, Carlson et al. reported that 45% of students participated in at least 30 minutes of MVPA during the school day in a sample of US schoolchildren in California and Washington (Carlson et al., 2013). The previous studies all employed large sample sizes with multiple schools and school systems using accelerometers in contrast to the current study describing one private school using the SWA.

Individual schools vary in their routines and priorities, which could explain why research suggests as much as 14.5% variation in PA based on the school attended (Griew, Page, Thomas, Hillsdon, & Cooper, 2010). Had the current study included more schools, the number of students meeting the recommendation may have been different. The school included in the current study had 110 minutes of weekly high quality PE (75% of the minutes were MVPA), two PE teachers, 30 minutes (Carlson et al., 2013) of daily recess, and ≤ 25 students per supervisor at recess. Carlson et al. observed that schools with four of the five following practices had twice as many MVPA minutes/day as those with only zero or one of the five: ≥ 100 min/week of PE, ≤ 75 students/supervisor in recess, ≥ 20 min/day of recess, having a PE teacher, and recess supervised by a non-classroom teacher. Having multiple elements of this index of PA practices could partially explain the high levels of MVPA in this sample. Recess and PE had higher EE than all other school day subjects. This was expected as the intention for these time periods is to incorporate opportunities for PA.

However, recent attention has been given to incorporating small bouts of PA into more traditional academic areas using activity breaks. Activity breaks are 5- to 10-minute breaks in classroom time when children are moving and may or may not include curriculum-based stimuli. Howie, Schatz, and Pate (2015) found 10- and 20-minute activity breaks enhanced math performance in 4^{th} and 5^{th} graders, though math curriculum was not used during the activity break. In addition, it has been suggested that because of children's activity patterns, the focus should be to increase the number of short-duration bouts of movement during the day (McManus, Chu, Yu, & Hu, 2011). Because it may not be possible for teachers to deduct time from academic subjects to incorporate activity breaks, content-based activity breaks seem promising. When comparing only traditional academic subjects (science, math, and language arts), science had higher EE than language arts. When looking at the teacher logs for the day, much of the time in science was spent working on projects and doing experiments while the language arts time was used reading, writing, and spelling. The latter are conventionally sedentary activities, but potential exists to increase EE while participating in these activities. This could be done by using curriculum based activity breaks or physically active brain breaks (e.g., 3-5 minute bursts of PA incorporated into learning time). Researchers should experiment with ways to incorporate PA into language arts through content-based activity breaks.

In addition to increasing physical well-being, incorporating PA during the school day may have cognitive and behavioral benefits as well. Recent reviews have observed positive relationships between increased PA and cognitive and brain health, academic performance, and psychosocial function in children (Kahn & Hillman, 2014; Singh, Uidtdewwillingen, Twisk, van Michelen, & Chinapaw, 2012). On-task behavior during class time has also been improved by adding PA into the school day (Bartholomew & Jowers, 2011; Jarrett et al., 2008; Lees & Hopkins, 2013; Mahar, 2011). Furthermore, Mahar et al. (2006) observed greater on-task behavior improvement for students starting with the lowest on-task behavior. This indicates multiple benefits may exist when children increase PA during the school day.

A limitation to the study was the relatively small sample size, which can lead to Type II errors. Also, a limitation of the SWA is the lack of ability to record activity in smaller than one-minute epochs. It has been observed that 95% of children's physical activity bouts last less than 15 seconds in duration (Bailey et al., 1995). With this understanding, it is possible that 1-minute epochs do not capture precise patterns of children's MVPA. Given low levels of PA among children, finding additional ways to incorporate movement into their daily patterns during the school day is valuable for health, cognitive, and behavioral benefits. Adding short activity breaks into language arts or other traditionally sedentary curricula could assist in this endeavor.

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APPENDICES

APPENDIX A

IRB APPROVAL LETTER

3/27/2015

Investigator(s): Holly R. Huddleston, Jennifer Caputo, Vaughn Barry
Department: Health and Human Performance
Investigator(s) Email: hrh2r@mtmail.mtsu.edu, jenn.caputo@mtsu.edu, vaughn.barry@mtsu.edu

Protocol Title: "**SenseWear armband in primary school children**"

Protocol Number: 15-202

Dear Investigators,

The MTSU Institutional Review Board, or a representative of the IRB, has reviewed the research proposal identified above. The MTSU IRB or its representative has determined that the study poses minimal risk to participants and qualifies for an expedited review under 45 CFR 46.110 and 21 CFR 56.110, and you have satisfactorily addressed all of the points brought up during the review.

Approval is granted for one (1) year from the date of this letter for 60 participants.

Please note that any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918. Any change to the protocol must be submitted to the IRB before implementing this change.

You will need to submit an end-of-project form to the Office of Compliance upon completion of your research located on the IRB website. Complete research means that you have finished collecting and analyzing data. **Should you not finish your research within the one (1) year period, you must submit a Progress Report and request a continuation prior to the expiration date.** Please allow time for review and requested revisions. Failure to submit a Progress Report and request for continuation will automatically result in cancellation of your research study. Therefore, you will not be able to use any data and/or collect any data. Your study expires **March 27, 2016.**

According to MTSU Policy, a researcher is defined as anyone who works with data or has contact with participants. Anyone meeting this definition needs to be listed on the protocol and needs to complete the required training. **If you add researchers to an approved project, please forward an updated list of researchers to the Office of Compliance before they begin to work on the project.**

All research materials must be retained by the PI or faculty advisor (if the PI is a student) for at least three (3) years after study completion and then destroyed in a manner that maintains confidentiality and anonymity.

Sincerely,

Aleka A. Blackwell
Institutional Review Board
Middle Tennessee State University

CHAPTER IV

WEB-BASED ACTIVITY BREAKS: IMPACTS ON ENERGY EXPENDITURE AND TIME OFF-TASK BEHAVIOR IN ELEMENTARY SCHOOL CHILDREN

Introduction

In addition to a multitude of physical benefits, physical activity (PA) increases measures of cognitive health (Best, 2010; Budde, Voelcker-Rehage, Pietrabyk-Kendziorra, Ribeiro, & Tidow, 2008; Drollette, Shishido, Pontifex, & Hillman, 2012; Pesce, Crova, Cereatti, Casella, & Bellucci, 2009) and academic achievement (Davis et al., 2011; Donnelly et al., 2009; Fisher et al., 2011; Kamijo et al., 2011; Lees & Hopkins, 2013) among children. Despite these positive benefits, only 42% of children in the United States (US) currently accumulate the recommended 60 daily minutes of moderate to vigorous physical activity (MVPA), 5 out of 7 days per week (US Department of Health and Human Services, 2008; Triano et al., 2008).

Because the majority of US children attend school 6-7 hours each day, the school day provides an ideal opportunity for increasing PA. Recommendations to incorporate additional PA in school include regularly scheduled physical education (PE) classes, daily recess with adequate game equipment, classroom activity breaks (AB), and modified school environments (Department of Health and Human Services, 2012). Of these, Bassett and colleagues (2013) concluded that mandated PE and classroom AB provided the most promising opportunities to increase energy expenditure (EE) during school hours in children. Research on classroom AB has shown improved academic success associated with increased time on-task (Bartholowmew & Jowers, 2011; Ma, Mare, & Gurd, 2015; Mahar et al., 2006). Time on-task is the proportion of time that a student spends engaged in learning, while time off-task is the proportion of time not spent engaged in learning. A review examining the effects of short bouts of PA (e.g., recess, active lessons in the classroom) on time on-task included five studies (Mahar, 2011). Mahar (2011) found including PA during the school day increased on-task behaviors, especially in those initially least on-task. This indicates brief PA bouts during the school day can have a positive effect on time spent in on-task behavior. An unknown factor in the link between classroom AB and time off-task is the minimal dose required relative to the quantity of AB necessary to elicit improvements in time off-task.

Finding ways to encourage teacher adoption of physically active lessons or AB in the classroom is important to the success of these interventions. The majority of studies using active lessons or AB employ researcher-led interventions or "train-the-teacher" type programs (Bartholowmew & Jowers, 2011; Carlson et al., 2015; Ma, Mare, & Gurd, 2015; Mahar et al., 2006). In a study evaluating the effectiveness of an AB intervention in Texas, it was reported that only 43.2% of teachers used the AB weekly, even when given training (Delk, Springer, Kelder, & Grayless, 2014). A program that requires no additional personnel and little training, such as a web-based program that leads AB, may increase adoption rates by teachers. Web-based programs can be free of charge, reduce the need for teacher training in AB curriculum, and are easy to use with Internet access. GoNoodle is a web-based interactive platform designed for implementing AB in the classroom (found at http://www.gonoodle.com). Therefore, the purpose of this study was to assess the effects of a 3-minute AB using the an online platform on EE and time off-task in 2nd graders. In addition, the dose response relationship between number of AB and EE and time off-task, respectively was examined.

Methods

Participants

Intact classes (*N* = 2) in a private, primary school in the southeastern part of the US were randomly selected by the school principal to participate in the study. All children in the selected 2nd grade classes were eligible to participate. Ethical approval was received by the Institutional Review Board (IRB) at the sponsoring university, and prior to data collection, informed consent was provided by each parent or guardian, and assent forms were signed by the students.

Instruments

SenseWear™ Mini Armband

The SenseWear Mini Armband (SWA; Body Media Inc. software version 8.1, Pittsburg PA) was used to monitor physical activity (PA) during breaks and language arts instructional lessons. The SWA, which has been validated with children (Calabro, Stewart, & Welk, 2013; Lee, Kim, Bai, Gaesser, & Welk, 2014), is a multi-sensor, portable activity monitor that is worn on the triceps of the upper left arm. It estimates energy expenditure (EE) by monitoring motion (via triaxial accelerometer), galvanic skin response, skin temperature, and heat flux. A small or medium SWA Velcro strap was used to secure the monitor to each child's arm. Children's EE was assessed during breaks and the full language arts instructional period (lessons plus breaks).

Observations

Direct observations of off-task behavior took place during the language arts instructional block each morning (Monday through Friday, 8:20-9:30 A.M.). In both classrooms, observations of tasks included phonics lessons, read aloud led by the teacher, individual reading, spelling, and grammar work. On-task and off-task behavior were assessed using a modified version of the Behavioral Observation of Students in Schools (BOSS) throughout the week (Shapiro, 2011). The BOSS is an observation system used to code behavior in the classroom. Observers watched student behavior for 10 seconds and recorded for 5 seconds before moving to the next student. On-task behaviors were classified as active engagement (e.g., answering a question, completing an assignment) or passive engagement (e.g, listening to the teacher). Off-task behaviors were classified as motor (e.g., fidgeting, drawing, or restlessness), verbal (e.g., talking to a classmate, speaking when not called upon), or passive (e.g., gazing off, not making eye contact to the speaker, head down on the table). Observers were prompted when to observe and when to record by an auditory instrument developed for the study. A partial interval recording schedule was used, meaning if any off-task behavior was observed during the 10 seconds, it was recorded in the respective off-task category. If multiple off-task behaviors were observed, the observer coded the most prominent off-task behavior. Lack of off-task behavior was coded as either active on-task or passive on-task.

Intervention

GoNoodle is a web-based product designed to help children channel their physical and emotional energy in a positive way. The content is primarily designated for grades K-5 and duration ranges from 1-25 minutes with different categories for desired effects (e.g., calming, energizing, stretching, and coordination). The segments chosen for intervention AB were Pop See Ko 2.0 and Cat Party and were 3:23 and 3:02 minutes in duration, respectively. Students followed along with the movement on the video with mostly overhead arm movements, jumping, or jogging in place. These videos were selected because of their popularity among current 2nd grade GoNoodle users nationwide (A. Briggs, GoNoodle co-founder, personal communication, Janurary 19, 2016). Non-active breaks consisted of 3-minutes of GoNoodle content from a combination of videos on the "Think About It" channel including: Be Grateful (1:19 minutes), Try Your Best (1:12), Speak Up (1:14), Build Patience (1:17), Take on the Day (1:19), and Find Peace (1:19). During the non-active breaks, videos lead children in focused positive intentions for the day.

Procedures

Following university IRB approval, information letters were sent home to parents of children in the 2nd grade classes. Observers (N = 2) were trained using the BOSS prior to data collection. Observers were given definitions of each behavior and practiced observations on the coding sheet in university classes. For 3 days prior to data collection, a familiarization period was used where the trained observers sat in classrooms for 20-minutes observing behavior for inter-rater reliability. This time was also used to accustom the children to having observers in the classroom and control for a potential Hawthorne effect. During the familiarization period, observers watched the same five 2nd grade students during the same 20-minute morning time periods and then compared notes. This practice continued until inter-rater reliability reached at least 90%. On the last day of familiarization, inter-rater reliability was 100%.

During familiarization, children also signed assent forms. The first day of data collection for each class was a Monday. As children in both classrooms arrived at school, the SWA was placed on the upper arm. Instructions were provided regarding the SWA, including a reminder to let the teacher know if the SWA caused any itching or irritation. Each day the armbands were put on the children by 8:00 A.M. and taken off by 9:30 A.M. The SWAs were randomized so that each child received a different device each day. Data from the SWA were downloaded and the devices were cleared following each school day.

Both classes participated in all 4 conditions (i.e., control, inactive break, 1AB, and 2AB) twice over a 2-week period. Breaks for each classroom used either an active video or positive motivational videos from GoNoodle. Conditions were randomized throughout each week, so classes did not have the same condition on the same day (see Table 1 for class data collection schedule). In the true control condition (CON), time off-task was observed for the same 20 minutes of the 8:20-9:30 A.M. time frame. Breaks in observation were taken between 20-minute observation periods where the active or non-active breaks were present in the other conditions. When inactive breaks (NAB) were used, time off-task was recorded in 20 minute increments with two inactive 3-4-minute

Table 1

Data Collection Schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1		CON	NAB	1AB	2AB
Week 2	NAB		2AB	CON	1AB

Note. CON = control; NAB = non-active break; 1AB = 1 active break; 2AB = 2 active breaks.

and ended with 20-minute observation period, with approximately a total of 60 minutes of observation time and 8 minutes break time. When one AB (1AB) was used, the schedule was similar to NAB, expect the final break used an active 3-4-minute GoNoodle video. When two AB (2AB) were used, the schedule was similar to NAB, but both breaks included an active 3-4-minute GoNoodle video. Because videos varied in length by 21 seconds, data were only collected for the first 3 minutes of each video (see Table 2 for the schedule for each condition).

Height, body mass, handedness, and birth date for each participant were obtained by the primary investigator during physical education class the week of data collection for proper algorithm analysis. Height and body mass were each measured twice with the average of the two measurements used in data analysis. Height in centimeters was measured using a portable stadiometer (Seca # 214, Birmingham, UK). A Seca (# 899, Hamburg, Germany) scale was used to measure body mass in kilograms for each child. Students wore their school uniform with shoes off during all measurements.

Data Analysis

Repeated measures Analyses of Variance (ANOVA) were performed using the Statistical Package for Social Sciences (SPSS) MIXED procedure with maximum likelihood estimation rather than the traditional linear model with least squares estimation because missing data occurred when a child was not present for all measurements during the two-week period (e.g., a child was at speech therapy or school nurse when part of data collection occurred). The general linear model approach would have analyzed only

Table 2

Classroom Intervention Schedule

	Time (AM)				
Condition*	8:20-8:39	8:40-8:44	8:45-9:04	9:05-9:09	9:10-9:30
CON	Instruction		Instruction		Instruction
NAB	Instruction	NAB	Instruction	NAB	Instruction
1AB	Instruction	NAB	Instruction	AB	Instruction
2AB	Instruction	AB	Instruction	AB	Instruction

Note. *All break conditions were 3-3.5 minutes in duration and instructional periods were 20 minutes in duration; CON = control; NAB = non-active break; 1AB = 1 active break; 2AB = 2 active breaks.

children with complete data for all measurement occasions. The maximum likelihood approach, in contrast, does not require complete data for all measurement occasions. Average EE (METS) was compared among NAB, 1AB, and 2AB conditions for the total 70-minute instructional period. A one-way repeated measures ANOVA was used to determine whether the number of active breaks was a significant predictor of EE within the instructional period. Energy expenditure was recorded for the same 70 minutes of the school day for each student. If a student was not present for the full 70 minutes, EE for that day was not included in the weekly average. Data were used for EE if the child had 70 minutes of wear time six out of eight days of data collection. The child also needed to have an SWA on-body time of at least 95% throughout the 70 minutes. If a child repeatedly removed the SWA during instructional time (i.e., wear time of < 95%), his or her daily EE was not included in the analysis.

A two-way repeated measures ANOVA was used to compare percent time off-task between observation time 2 (middle observation period) and observation time 3 (last observation period) with 3 break types (CON, NAB, and 1AB). Observation time 2 (pre-break) and observation time 3 (post-break) were used since between those observations, all analyzed break types differed. Percent time off-task was determined by taking the total number of off-task observations (active or passive engagement) during a 20-minute observation period, divided by total number of observations in that same period, and then multiplying by 100 to convert the proportion to a percentage. Percent time off-task was figured for the 20-minute observation time before and after the last break for NAB and 1AB and the last two 20-minute segments of CON. This ensured that all comparison observations occured during approximately the same time of day in each condition for both classrooms.

Different numbers of activity breaks (0, 1, or 2) were analyzed to see which condition produced lowest percent time off-task for all combined observation time (average of observation time 1, observation time 2, and observation time 3). A one-way repeated measures ANOVA was used to determine whether number of AB was a significant predictor of percent time off-task. A one-way repeated measures ANCOVA analysis determined whether number of AB (NAB, 1AB, or 2AB) was a significant preditctor of percent time off-task when controlling for average EE during the full instructional period (lessons plus breaks). All tests were within subjects designs on both factors (condition and time).

Results

Of 40 possible students in the selected classrooms, all parents and/or guardians returned informed consent documents giving permission for their child to participate in the study. However, data from 2 participants were excluded because they missed more than two of the eight data collection days. Therefore, data from 38 participants (*M* age = 8.6 ± 0.4 years; body mass = 31.2 ± 7.2 kg; height = 133.8 ± 6.8 cm; sex = 26 male, 12 female) were used in the analyses.

Average percent of wear time for the SWA across 8 days was 99.8%. Even though present, 2 participants' data were not included for 1 day each because SWA wear time was less than 95%. One student came to school after the lesson began and the other repeatedly took off the SWA throughout the lessons. The average number of moments each participant was observed per lesson was 3.5 ± 0.2 moments (CON = 3.7 ± 0.4; NAB = 3.6 ± 0.2; 1AB = 3.0 ± 0.3; 2AB = 3.6 ± 0.3). The average number of minutes per lesson and break was 16.7 ± 0.2 (CON = 17.3 ± 1.8; NAB = 17.1 ± 2.4; 1AB = 16.0 ± 0.5; 2AB = 16.8 ± 0.6) and 3.7 ± 0.2 minutes (CON = 3.6 ± 0.1; NAB = 3.1 ± 0.4; 1AB = 3.9 ± 0.1; 2AB = 4.0 ± 0.0), respectively.

Descriptive statistics for EE rates within the breaks only and full instructional period (lessons plus breaks) are shown in Table 3. All EE values are in metabolic equivalents (METS). When comparing EE within the breaks only, the one-way repeated measures ANOVA indicated number of breaks (NAB, 1AB, or 2AB) was a significant predictor of average EE, $F(2, 67.23) = 55.86$, $p < .001$. When comparing EE for the full instructional period, number of breaks was also a significant predictor of EE, $F(2, 68.47) = 25.85$, $p < .001$. Pairwise comparisons were conducted using the Sidak procedure and reported in Table 4. For both analyses, 2AB produced higher EE than 1AB and NAB. Also for both analyses, 1AB produced higher EE than NAB.

Descriptive statistics for percent time off-task are shown in Table 5. Students occasionally had missing data because of various short absences from the classroom (e.g., speech therapy, nurse visit). Because of these occurances, missing data were statistically controlled for using maximum liklihood estimation. Students had to have a combined 6 days worth of data to be included in analyses. A two-way repeated measures ANOVA with break type (CON, NAB, 1AB) and lesson (pre-break lesson and post-break lesson) as within subjects factors was used to predict percent time off-task. There was a significant interaction between break type and lesson, $F\ (2, 163.95) = 4.73$, $p = .01$. As

Table 3

Rates of Energy Expenditure (METS)

Number of breaks	Mean	Standard error	95% CI Lower bound	95% CI Upper bound
Breaks only				
NAB	2.1	0.1	1.8	2.4
1AB	3.3	0.1	3.0	3.5
2AB	4.1	0.1	3.9	4.4
Lessons & breaks				
NAB	2.2	0.1	2.0	2.3
1AB	2.7	0.1	2.5	2.9
2AB	3.0	0.1	2.8	3.2

Note. *N* = 38 for all conditions; CI = confidence interval; NAB = non-active break; 1AB = 1 active break; 2AB = 2 active breaks; METS = metabolic equivalents.

Table 4

Sidak Comparisons for Rate of Energy Expenditure

Comparison		Mean difference	95% CI Lower bound	95% CI Upper bound	Cohens' *d*
Breaks only					
2AB	1AB	0.9*	0.4	1.3	1.1
2AB	NAB	2.0*	1.6	2.5	2.6
1AB	NAB	1.2*	0.7	1.6	1.5
Lessons & breaks					
2AB	1AB	0.3*	0.0	0.6	0.7
2AB	NAB	0.8*	0.6	1.1	1.7
1AB	NAB	0.5*	0.2	0.8	1.1

Note. * Significance testing based on familywise alpha of .05; CI = confidence interval; 1AB = 1 active break; 2AB = 2 active breaks; NAB = non-active break.

Table 5

Descriptive Statistics for Percent Time Off-Task

Break type	Observation time	*n*	Mean	Standard error	95% CI Lower bound	95% CI Upper bound
CON	Pre-break	34	18.0	2.7	11.8	24.2
	Post-break	34	25.0	2.7	18.8	31.2
NAB	Pre-break	35	20.4	2.7	14.2	26.5
	Post-break	30	19.4	2.9	12.9	26.0
1AB	Pre-break	34	14.9	2.7	8.7	21.1
	Post-break	31	6.5	2.9	0.1	13.0

Note. CON = control; NAB = non-active break; 1AB = 1 active break.

well, there was a significant main effect for break type, F (2, 166.67) = 10.52, $p < .001$, but not for lesson, F (1, 164.75) = .13, p =.72.

Simple effect one-way repeated measures ANOVAs were conducted to compare percent time off-task across each type of break ($\alpha = .025$) Pairwise comparisons were conducted using the Sidak procedure and reported in Table 6. Type of break did not affect percent time off-task during the pre-break lesson, F (2, 163.05) = 1.23, p =.30. However, type of break did affect percent time off-task during the post-break lesson, F (2, 167.26) = 13.67, $p < .001$. During the post-break lesson, the AB condition had significanly lower percent time off-task than CON or NAB conditions. No difference in percent time off-task existed between the CON or NAB conditions.

The average combined instructional percent time off-task was 18.4 for the NAB condition (n = 30, M = 18.4, 95% CI: 15.2, 21.7), 11. 8 for the 1AB condition (n = 30, M = 11.8, 95% CI: 8.5, 15.0), and 9.3 for the 2AB condition (n = 34, M = 9.3, 95% CI: 6.3, 12.2). The one-way repeated-measures ANOVA indicated time off-task differed among number of AB, F (2, 65.66) = 10.26, $p < .001$ The Sidak comparisons indicated percent time off-task was higher for NAB than 1AB (mean difference = 6.6, 95% CI: 1.3, 12.0, Coden's d = 0.8) and 2AB (mean difference = 9.1, 95% CI: 4.1, 14.2, Cohen's d = 1.0). However, there was no difference between in percent time off-task for 1AB and 2AB (mean difference = 2.5, 95% CI: -2.5, 7.5, Cohen's d = 0.3). A one-way repeated-measures ANCOVA was used to examine a potential difference in percent time off-task by number of AB when controlling for EE during the full instructional period of its respective condition. Results indicated controlling for EE did not have a different effect.

Table 6

Sidak Comparisons for Changes in Percent Time Off-Task Across Break Types

Comparison		Mean difference	95% CI Lower bound	95% CI Upper bound	Cohens' *d*
Pre-break lesson					
CON	AB	3.1	-6.3	12.4	0.2
NAB	CON	2.4	-6.9	11.7	0.2
NAB	AB	5.5	-3.8	14.8	0.3
Post-break lesson					
CON	NAB	5.6	-4.1	15.3	0.4
CON	AB	18.5*	8.9	28.1	1.2
NAB	AB	12.9*	2.9	22.9	0.8

Note. *Significant at the .05 familywise alpha level (i.e., .025 per simple effect); CON = control; NAB = non-active break; AB = 1 active break.

Discussion

The purpose of this study was to examine the effectiveness of a 3-minute web-based AB intervention on EE and percent time off-task in 2nd grade children. Also, the dose response relationship between number of AB and percent time off-task was explored. Children expended significantly more energy with each additional AB. In relation to total EE across the combination of instructional time and breaks, children also expended significantly more energy with each additional break. Children spent less time in off-task behaviors during lessons after AB, indicating higher attention during the instructional period after participating in an AB. Time off-task across all combined instructional periods was correspondingly lower for 1 and 2 AB than NAB. Further, when controlling for EE, time off-task was also lower for 1 and 2 AB than NAB.

Many opportunities exist for children to increase PA during the school day, and these data demonstrate web-based AB are a viable option for achieving this goal. Activity breaks in schools have been highlighted by the US Department of Health and Human Services (2012) and Center for Disease Control and Prevention (2013) for increasing PA in children. In the current study, children increased average MET levels of 2.2 during an instructional period with inactive breaks to average MET levels of 3.0 during the same instructional period with two 3-minute AB. The increased MET level falls into the moderate intensity activity range in accordance with guidelines from the American College of Sports Medicine (Pescatello, 2014). In addition, the increase in EE intensity during active breaks averaged 4.1 METS, which is well within the moderate intensity range.

Increased school day PA from use of AB was also observed by Bartholomew and Jowers (2011). During a pilot study for the Texas I-CAN! curriculum, an average daily step count increase of 1,000 steps was detected. An expanded use of Texas I-CAN! indicated an average difference of 600 steps between classrooms using AB and those using NAB (2011). More recently, Drummy and colleagues (2016) found that implementation of three daily 5-minute AB significantly increased weekday moderate to vigorous physical activity (MVPA). Accelerometer data determined that teacher led AB increased MVPA in a sample of 9- and 10-year old children by 9.5 minutes from baseline to post 12-week intervention. Increased MET levels were also observed in evaluation of the Take10! program, ranging from approximately 5 to 7 METS in 1st, 3rd, and 5th grade classrooms (Stewart, Dennison, Kohl, & Doyl, 2004). The current study expands upon results from the Texas I-CAN! (Bartholomew & Jowers, 2011) and Drummy et al. (2016) studies indicating participation in AB can increase PA during the school day. Current data support the recommendation that AB are an effective way to increase the accumulation of PA (Bassett et al., 2013).

In addition to health benefits, this study supports the idea that web-based AB are helpful for increasing academic focus in a 2nd grade classroom. Children were more focused (e.g., lower time off-task) after AB than after NAB. These findings are similar to other studies that have examined the effects of AB on off- and on-task behavior. Percent time off-task decreased after a 4-minute AB in 2nd and 4th grade children (Ma, Mare, & Gurd, 2014) compared to a NAB. After the AB, children in 2nd grade had lower scores in all off-task behaviors (i.e., motor, verbal, and passive), but in 4th graders, only passive and motor scores were lower than the NAB groups. Similarly, Bartholomew and Jowers (2011) noted a significant increase in time on-task after an AB compared to a NAB in 4th grade children. This effect was observed to a greater degree in overweight children than non-overweight children. Though Bartholomew and Jowers (2011) did not focus on off-task behaviors as the current study, time on-task was recorded in a similar way and the results are comparable. Additionally, time on-task increased significantly after 10 minutes of Energizers (an AB curriculum) in elementary children compared to NAB (Mahar et al., 2006). Though the findings of these studies yield similar results, the current study was the only one to include a web-based AB program rather than a teacher/researcher lead AB program.

In the three previous studies (Bartholomew & Jowers, 2011; Ma, Mare, & Gurd, 2014; Mahar et al., 2006), all students participated in AB inside the classroom. More recently, the on-task behavior of 5th and 6th grade boys was observed after a 10-minute AB outside the classroom (Wilson, Olds, Lushington, Petkov & Dollman, 2016). Time on-task remained unchanged after the AB compared to a non-active reading break. It is unknown whether the conclusions of Wilson et al. (2016) differ from the others because of the AB location (i.e., outside versus inside the classroom) or possibly the older mean age of the sample.

Current findings are important because of the sustainability of implementing web-based AB. Teachers do not have to be training in a specific AB curriculum, making it easier and more likely for them to use AB on a regular basis. With web-based AB, teachers themselves do not have to be comfortable leadng physical AB in order to use them in their classrooms. In addition, web-based AB can have a variety of videos that keep children interested in the breaks. In a study analyzing barriers to teachers' use of AB, 20% cite lack of a suitable curriculum as a concern (Perera, Frei, Frei, & Bobe, 2015). Competing academic expectations are also mentioned by 83% of teachers as a common barrier, yet web-based AB can offer content that is aligned with core state academic standards. Web-based, content-related AB could be a viable solution to the aforementioned barriers.

Many states have legislation with standards requiring schools to provide opportunities for PA. In the state where this study took place, all schools must provide at least three 15-minute periods per day of unstructured PA for kindergarten and 1st grade and two 20-minute periods at least 4 days per week for grades 2 through 6 (TN H.R. 2148, 2016). This can be a challenge during the colder months or rainy weeks when weather prohibits outdoor play. Participating in classroom AB provides teachers with an opportunity to meet these criteria, regardless of weather conditions. Moreover, the state attorney general authorized the use of programs, such as GoNoodle and others as valid PA minutes (Slatery, Blumstein, & Ballard, 2016).

Although the sustained effects of regular AB implementation were not examined in this study, the dose response for number of daily breaks was examined. Positive results for on- and off-task behaviors have previously been shown with 10 (Mahar et al., 2006) and 4 (Ma, Mare, & Gurd, 2014) minutes. In the current study, the AB ranged in duration from 3 to 3.5 minutes. When we compared a NAB (of similar duration) to 1 AB and 2 AB in a 70-minute instructional period, the effects on percent time off-task for the full instructional period were similar for both AB conditions. Percent time off-task for the full instructional period was significantly lower in the 1AB and 2AB conditions than the NAB, though no difference existed between the different AB conditions. This indicates that a classroom AB can lower children's time off-task with as little as one 3-minute AB in an instructional period.

This is useful for administrators and teachers who seek to understand how much time is required to receive the benefits of incorporating AB into the school day. While is is generally accepted that increased PA is associated with physical health benefits for children, teachers are held accountable for academic outcomes. The current results indicate taking short AB during academic instruction can decrease off-task behaviors, which could improve academic outcomes. Also, while time off-task did not decrease in the NAB condition as it did in 1AB and 2AB, it did remain the same. This means that even non-active breaks during academic instruction may keep children from increasing percent time off-task behaviors as it did in the condition with no breaks (CON).

There are limitations associated with collecting data within an active classroom. Though the response rate among children was high, the observations required to analyze off-task behavior are labor intensive and less suitable for a large-scale study, limiting the number of classes included in the current study. In addition, though 40 children were included in the full sample, absenteeism and other short-term classroom absences during the normal school day routine (e.g., bathroom breaks, speech therapy, nurse visits, etc…) impacted the sample size of some analyses. Also, while most children were enthusiastic about participating in the GoNoodle videos, a few were uninterested and chose to read at their desks during all breaks. The results of this study are only generalizable to the population within the given school. Boys were twice as prevalent as girls in the given population and ethnic diversity was narrow. Having a sample inclusive of a fuller socioeconomic and ethnic spectrum would have made the findings more applicable to a broader population range.

Though previous studies have indicated AB are physically and cognitively beneficial in children, this is the first study to assess the effectiveness on a web-based AB in these domains. The long-term effects of such a web-based intervention are still unknown. Future research should explore the implications of web-based AB inclusion on EE and time off-task or other measures of classroom behaviors over longer periods of time. In addition, though children moved at moderate levels of PA during the AB, it is unknown whether the inclusion of 3-minute web-based AB would make a significant impact on daily minutes of PA at school. There are a variety of web-based videos for educators to use, and it is possible that results would vary according to type and length of videos used in the classroom.

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APPENDICES

APPENDIX A

IRB APPROVAL LETTER

IRB
INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129

MIDDLE TENNESSEE STATE UNIVERSITY

IRBN001 - EXPEDITED PROTOCOL APPROVAL NOTICE

Wednesday, April 06, 2016

Investigator(s):	Holly Huddleston, Jennifer Caputo, Vaughn Barry
Investigator(s') Email(s):	*hrh2r@mtmail.mtsu.edu, jenn.caputo@mtsu.edu, vaughn.barry@mtsu.edu*
Department:	Health and Human Performance
Study Title:	*Web-based activity breaks: Impact on energy expenditure and time on-task in elementary school children*
Protocol ID:	**16-2215**

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU Institutional Review Board (IRB) through the **EXPEDITED** mechanism under 45 CFR 46.110 and 21 CFR 56.110 within the category *(1) Clinical studies of drugs and medical devices* A summary of the IRB action and other particulars in regard to this protocol application is tabulated as shown below:

IRB Action	APPROVED for one year from the date of this notification	
Date of expiration	**4/6/2017**	
Participant Size	46	
Participant Pool	**Two 2nd grade classes at Lipscomb Academy**	
Exceptions	Click here to enter text.	
Restrictions	Click here to enter text.	
Comments	Click here to enter text.	
Amendments	**Date**	**Post-approval Amendments**
		Click here to enter text.

This protocol can be continued for up to THREE years (**4/6/2019**) by obtaining a continuation approval prior to **4/6/2017**. Refer to the following schedule to plan your annual project reports and be aware that you may not receive a separate reminder to complete your continuing reviews. Failure in obtaining an approval for continuation will automatically result in cancellation of this protocol. Moreover, the completion of this study MUST be notified to the Office of Compliance by filing a final report in order to close-out the protocol.

Continuing Review Schedule:

Reporting Period	Requisition Deadline	IRB Comments
First year report	4/6/2017	Click here to enter text.
Second year report	4/6/2018	Click here to enter text.
Final report	4/6/2019	Click here to enter text.

The investigator(s) indicated in this notification should read and abide by all of the post-approval conditions imposed with this approval. Refer to the post-approval guidelines posted in the MTSU IRB's website. Any unanticipated harms to participants or adverse events must be reported to the Office of Compliance at (615) 494-8918 within 48 hours of the incident. Amendments to this protocol must be approved by the IRB. Inclusion of new researchers must also be approved by the Office of Compliance before they begin to work on the project.

All of the research-related records, which include signed consent forms, investigator information and other documents related to the study, must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application. The data storage must be maintained for at least three (3) years after study completion. Subsequently, the researcher may destroy the data in a manner that maintains confidentiality and anonymity. IRB reserves the right to modify, change or cancel the terms of this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University

Quick Links:

Click here for a detailed list of the post-approval responsibilities.
More information on expedited procedures can be found here.

APPENDIX B

SAMPLE OBSERVATION SHEET

BLANK FORM FOR THE BEHAVIORAL OBSERVATION OF STUDENTS IN SCHOOLS

Date:________________________ Observer:____________________

Classroom: ____________________ Block (Circle One): 1st 2nd 3rd

Moment	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Minute	0	:15	:30	:45	**1**	:15	:30	:45	**2**	:15	:30	:45	**3**	:15	:30	:45
ID	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
AET																
PET																
OFF-M																
OFF-V																
OFF-P																

Moment	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Minute	**4**	:15	:30	:45	**5**	:15	:30	:45	**6**	:15	:30	:45	**7**	:15	:30	:45
ID	17	18	19	20	1	2	3	4	5	6	7	8	9	19	11	12
AET																
PET																
OFF-M																
OFF-V																
OFF-P																

Moment	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Minute	**8**	:15	:30	:45	**9**	:15	:30	:45	**10**	:15	:30	:45	**11**	:15	:30	:45
ID	13	14	15	16	17	18	19	20	1	2	3	4	5	6	7	8
AET																
PET																
OFF-M																
OFF-V																
OFF-P																

Moment	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64
Minute	**12**	:15	:30	:45	**13**	:15	:30	:45	**14**	:15	:30	:45	**15**	:15	:30	:45
ID	9	10	11	12	13	14	15	16	17	18	19	20	1	2	3	4
AET																
PET																
OFF-M																
OFF-V																
OFF-P																

Moment	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Minute	**16**	:15	:30	:45	**17**	:15	:30	:45	**18**	:15	:30	:45	**19**	:15	:30	:45
ID	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
AET																
PET																
OFF-M																
OFF-V																
OFF-P																

CHAPTER V

OVERALL CONCLUSIONS

This dissertation focused on the measurement of EE and benefits of increased EE through AB in elementary school classrooms. In the first study, EE during academic subjects throughout the school day was compared. After EE in language arts was found to be significantly lower than other subjects, the second study was designed to analyze the effects of a web-based AB intervention during language arts on specific behaviors in second grade school children. Specifically, data were collected on EE and time off-task as AB were implemented during the language arts.

Initially, EE was measured in 2^{nd}, 3^{rd}, and 4^{th} graders (N = 33) during 6 hours of the school day using the SWA. Classroom teachers filled out daily logs regarding times and locations of different subjects areas throughout each day. When all areas were compared, children had higher relative EE during recess and physical education, *Wilks'* $F(7, 23) = 52.2$, $p = .00$, $\eta_p^2 = .94$. However, when only academic subjects were compared (math, science, language arts), relative EE was higher in science than language arts. Because EE was found to be lower in language arts, it was used as the subject during which the EE intervention was implemented.

Web-based AB were used in EE intervention during the language arts instructional time in 2^{nd} graders. Specifically, the effects of a 3-minute AB on children's EE and time off-task were analyzed. Children participated twice in each of the 4 conditions: 2 active breaks (2AB), 1 active break (1AB), non-active breaks (NAB), and a true control of no breaks (CON). Energy expenditure was assessed using the SWA and time off-task was observed using the BOSS.

When comparing effects of NAB, 1AB, and 2AB on EE during breaks only, a one-way repeated measures Analysis of Variance (ANOVA) indicated number of breaks was a significant predictor of EE, $F(2, 67.23) = 55.86$, $p < .001$. The mean metabolic equivalent (MET) level increased with each additional AB with NAB, 1AB, and 2AB producing an average of 2.1, 3.3, and 4.1 METS, respectively. In addition, when comparing EE for the full instructional period, number of breaks also significantly predicted EE $F(2, 68.47) = 25.85$, $p < .001$. Even with inactive instruction time included in these values, the MET level increased with each added break for the full instructional period (NAB = 2.2, 1AB = 2.7, 2AB = 3.0). These data indicate that with each additional AB, EE increases. Also, when participating in two active 3-minute breaks (2AB), the MET level is within the moderate physical activity range. This is important because it supports previous research and recommendations from the Center for Disease Control and Prevention indicating AB are an effective way to increase EE in children during the school day.

Average percent time off-task was compared between observation time 2 (middle observation period) and observation time 3 (last observation period) for 3 break types, CON, NAB, and AB. A significant interaction was found between break type and lesson (pre- or post-break lesson), F (2, 163.95) = 4.73, $p = .01$. There was also a significant effect for break type, F (2, 166.67) = 10.52, $p < .001$, but not for lesson, F (1, 164.75) =

.13, $p = .72$. Pairwise comparisons indicated during the post-break lesson that 1AB and NAB conditions produced significantly lower time off-task scores than CON. This indicates a break improves time off-task scores, regardless of whether the break is active or non-active. Therefore, taking a break during language arts instruction not only maintains, but can improve children's focus after the break. Given AB can help improve the physical health of a child by increasing daily EE, knowing the break can also potentially improve cognitive health by increasing focus is an optimistic outcome for educators and policymakers. Those in charge of organizing schedules during the school day should be aware that 3-minute breaks, active or non-active, taken from instruction time can help student focus. Whether improvements in time off-task as a result of classroom AB would lead to improvements in academic outcomes (e.g., grades) is a question for future research.

The benefits of multiple AB was explored by comparing the combined instructional percent time off-task for 2AB, 1AB, and NAB. The reason this analysis was conducted was to potentially determine a minimum number of breaks needed to decrease time off-task. The one-way repeated measures ANOVA indicated time off-task differed among conditions, F (2, 65.66) = 10.26, $p < .001$, with 2AB (9.3%) and 1AB (11.8%) producing lower time off-task scores than NAB (18.4%). These data suggest that even one 3-minute active break can decrease time off-task throughout a full language arts lesson. This is also beneficial for teachers and policy makers because a 3-minute break does not take an extensive amount of time from classroom instruction. Therefore, improvements in EE and time off-task can be made with minimal time commitment.

Many of the results from the present study are similar to prior research on AB. This study is unique because of the use of a web-based AB program. Using a web-based program increases the feasibility of AB implementation, regardless of teacher fitness status and/or level of comfort leading children in PA. In addition, 3 minutes is the shortest AB duration yet to be explored. Therefore, a large amount of class time need not be used in order to experience physical and cognitive benefits of AB. This study only examined the acute effects of web-based AB. Future research should implement a longer intervention period to see if benefits would exist with sustained use of web-based AB in the classroom.

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