



Impact of short bouts of physical activity on attention-to-task in elementary school children

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ARTICLE INFO

Available online 31 January 2011

ABSTRACT

Objective. The study's objective was to describe the measurement of on-task behavior and review the research on the effects of short physical activity breaks on attention-to-task in elementary school students, with a particular focus on a promising approach to improving on-task behavior with short bouts of physical activity in the classroom setting.

Methods. Procedures to directly observe attention-to-task were detailed. Published studies that measured attention-to-task in elementary school students following physical activity breaks were reviewed.

Results. Direct measurement of attention-to-task is intensive and demanding on observers. Previous research on attention-to-task following physical activity breaks is sparse. The limited evidence suggests a small to moderate improvement on attention-to-task following physical activity breaks (Effect Sizes typically ranged from 0.13 to 0.60). Teachers can be trained in a relatively short time to effectively lead classroom-based physical activities. Students who participated in classroom-based physical activities that incorporate academic concepts demonstrated significantly better improvements (+8.3%) in attention-to-task than control group participants (-3.1%).

Conclusions. Attention-to-task is a variable that directly relates to concerns of classroom teachers. The limited available research has demonstrated moderate to good evidence that physical activity during the school day improves attention-to-task in elementary school students. Because of the positive effects of physical activity on attention-to-task, it is recommended that elementary school teachers consider implementing physical activity sessions throughout the school day in the form of recess and classroom-based physical activities.

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Introduction

The high levels of overweight and obesity in children (Ogden et al., 2006) have been associated with low levels of physical activity (Nelson et al., 2006). Physical activity levels are impacted by the opportunities available to youth to be active. Several concerns can limit opportunities for children to be active, including a shortage of play spaces, unsafe neighborhoods, increased screen time, and increased demands of schooling. The current emphasis on end of grade testing can cause decreased opportunities during school for students to be physically active by inadvertently pressuring administrators and teachers to spend more sedentary time in the classroom and less physically active time in physical education and recess in an effort to improve standardized test scores. However, because children spend many hours at school, facilities and equipment are often available, and personnel who could lead physical activities are in place, the school environment provides an excellent opportunity for children to be physically active (Pate et al., 2006).

It is recommended that children engage in ≥ 60 min of physical activity daily (USDHHS, 2008). Because most children spend 6 h or

more per day in school, it is reasonable that at least 30 min of this time be devoted to physical activity. Physical activity during school hours may occur during physical education, recess, and classroom instruction (Mahar et al., 2006b). In addition, before-school and after-school programs can provide additional opportunities for children to be physically active.

Based on a nationally representative sample of schools, Lee et al. (2007) estimated that only 57% of school districts required regularly scheduled recess for elementary school students. In addition, few schools (4% of elementary schools, 8% of middle schools, and 2% of high schools) in the United States provided daily physical education (Lee et al., 2007).

Troiano et al. (2008) analyzed the physical activity levels of a nationally representative sample from the National Health and Nutrition Examination Survey. In this study, physical activity was directly assessed with accelerometers. Their data provided evidence that most youth do not participate in sufficient levels of physical activity, with 42% of children aged 6 to 11 years and only 8% of adolescents obtaining the recommended 60 min per day of moderate intensity or greater physical activity.

The purposes of this paper were to describe the measurement of on-task behavior and provide a review of literature on research that has examined the effects of short physical activity breaks on

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attention-to-task in elementary school students, including findings on a promising approach to improving on-task behavior with short bouts of physical activity in the classroom setting.

2. Measurement of attention-to-task

Because of the importance of direct observation to answer the question of whether physical activity impacts attention-to-task, a brief overview of systematic observation is provided in this section. Behaviors (such as on-task behavior or physical activity) are typically more difficult to measure than outcomes (such as standardized test scores or aerobic fitness). Thus, well defined rules and strict adherence to those rules are essential to providing data that are credible.

Step 1. The first step is to accurately define the behavior in question so that it can be measured reliably (Van Houten and Hall, 2001). The behavior can be on-task behavior, inattention-to-task, or fidgety behavior, among several other behaviors that might be related to academic performance. The behavior must be observable and observers should be able to associate codes with the observed behavior. The key is to define the behavior so that little is left to the subjective interpretation of the observers. Of course, this is difficult to do and the observed behavior always depends to some extent on the ability of the observers. A good definition is one that is written clearly (so that someone can easily repeat it in his/her own words), specifies the boundary of the behavior, and refers to observable characteristics of behavior.

Step 2. The second step is to train observers to be objective and nonjudgmental (McKenzie, 2010). Observers, who are often graduate or undergraduate students, must first be oriented to the science of systematic observation, including ethical issues, confidentiality, and objectivity. Then it is important to test that observers know the definition of what is being observed. Examples of the behavior of interest and how they will be scored should be thoroughly discussed. Observers should then practice coding videotaped and actual behavior. It is important that some of the practice observing take place in the environment in which the study will take place. This will have the dual effect of orienting observers to the setting of interest and of habituating the participants to the observers so that the participants are less likely to behave differently than normal because observers are present. Finally, because observation skills can erode with time, it is important to provide booster training to assure observers maintain their skills and record reliably.

Step 3. Another important step is to determine the type and length of recording to be used. Researchers need to consider the cost, burden placed on the observer, and time required for recording the observation. An audio file needs to be prepared to cue observers when to observe and when to record behaviors. Types of recording include: whole interval recording, partial interval recording, and momentary time sampling.

For interval recording, observation sessions are divided into periods [e.g., observe for 5 s, then record for 5 s]. The observer records the occurrence or nonoccurrence of the behavior during these intervals. In whole interval recording, the behavior being observed must persist throughout the entire interval to be scored for that interval. In partial interval recording, the behavior of interest is scored for that interval if it occurs at all during the interval. Partial interval recording may result in higher values of on-task behavior than whole interval recording, so it is important for researchers to clearly state their recording methods. Partial interval recording appears to be more appropriate for disruptive behaviors (e.g., off-task behaviors) that occur for brief periods. In momentary time sampling, the observer records ongoing behaviors only at the end of the time interval. For example, if the observation interval is 5 s, the observer would record the participant's behavior only at the moment at the end of the

interval. This is not a useful method for recording infrequent short duration events (Van Houten and Hall, 2001).

Step 4. Interobserver reliability must be assessed for all observation studies. The credibility of the observation data depends upon adequate levels of interobserver reliability. Reliability in this sense refers to the agreement of two observers. The concept is that two independent observers should record the same code when they observe the same participant at the same time. If levels of agreement are low, then readers have little confidence in the data. Conversely, it is unlikely that two independent observers will consistently record the same code unless they are recording the same behavior. Thus, when researchers demonstrate adequate levels of interobserver reliability the data are typically credible to the reader.

Interobserver reliability is determined by having a second observer independently record the same behavior at the same time as the first observer. The level of agreement among trained, independent observers is often expressed as percent agreement and is calculated as follows:

$$\text{Percent Agreement} = \frac{\text{number of agreements}}{\text{number of agreements} + \text{number of disagreements}}$$

Step 5. After adequate interobserver agreement is obtained, study observations can begin. Interobserver agreement should then be documented during study observations.

The following suggestions are offered as recording etiquette for school-based direct observation studies (Van Houten and Hall, 2001):

1. Have the teacher introduce the observers with a general statement about interest in doing research.
2. The entrance and departure from the classroom should coincide with natural breaks in routine.
3. When two observers are present, they should talk with each other as little as possible before observations, and not at all during the observations.
4. Observers should not interact with the participants being observed.
5. The interest in the specific child being observed should be disguised so that the participants do not know who is being observed at any given time.

Attention-to-task in elementary school students

Barros et al. (2009) conducted a large-scale study on the effects of recess on classroom behavior. Using data on >10,000 children aged 8 and 9 years from the Early Childhood Longitudinal Study, they compared group classroom behavior of children who received recess with children who did not receive recess. Recess data were from a questionnaire completed by teachers. Teachers indicated the number of days per week and number of times per day children have recess and the amount of time children spend in recess (in 15 minute intervals). These data were then categorized into two levels: (1) none/minimal break or (2) some recess.

Group classroom behavior was assessed via teachers' ratings of classroom behavior. Teachers rated classroom behavior using the following scale: (1) misbehaves very frequently and is almost always difficult to handle, (2) misbehaves frequently and is often difficult to handle, (3) misbehaves occasionally, (4) behaves well, or (5) behaves exceptionally well.

Results demonstrated that 71% of this sample had 'some recess' and 29% had 'no or minimal recess'. Table 1 presents a comparison of classroom behavior scores for students who had some recess vs. students who had no or minimal recess. Barros et al. reported that the difference of 0.16 (on a 1 to 5 scale) was statistically significant. Using the data reported by Barros et al., Cohen's delta (*ES*) was calculated to examine the size of the mean difference. The *ES* for the weighted average for all recess groups of 0.18 indicates that the difference in

Table 1
Classroom behavior scores for students with various levels of recess

Level of Recess	Mean (SD)	n	Effect Size
None/minimal break	3.44 (0.90)*	3369	–
Little recess	3.62 (0.81)	595	0.18
More recess	3.57 (0.90)	2132	0.13
A lot of recess	3.61 (0.83)	2299	0.17
Minimal recess/lunch	3.60 (0.85)	3027	0.16
Recess/lunch > 30 min	3.74 (0.93)	107	0.30
Weighted average of all recess groups	3.60 (0.85)	8160	0.18

Note: Effect size calculated with Cohen's delta compared to None/minimal break group.
* $p < 0.001$ for none/minimal break vs. all other groups.

Table developed from data presented in: Barros, R.M., Silver, E.J., Stein, R.E.K., 2009. School recess and group classroom behavior. *Pediatrics* 123, 431–436.

group classroom behavior between the students who had some recess and those who had no or minimal recess was small (Cohen, 1988).

Barros et al. (2009) then categorized the 'some recess' students according to level of exposure to recess as follows: (1) little recess (1–15 min twice or more daily), (2) more recess (16–30 min twice or more daily), (3) a lot of recess (>30 min twice or more daily), (4) minimal recess/lunch (16–30 min once daily), or (5) recess/lunch of >30 min once daily. The authors noted that information about lunch and recess obtained from the teachers' questionnaire was overlapping in some response categories. Table 1 presents mean scores for group classroom behavior for these groups. All groups with any amount of recess had significantly higher mean group behavior scores than the group with no recess. Mean differences between the group that received no or minimal recess and the groups that received less than 30 min per day of recess were small (≤ 0.18 on a 1 to 5 scale; effect sizes ≤ 0.20). Although the researchers concluded that a break during the school day of >15 min was associated with better group classroom behavior, the size of the differences in group classroom behavior were relatively small. The reason these small differences are statistically significant can probably be explained by the large sample sizes used in the comparisons. The authors recognized several limitations, including that group classroom behavior was used rather than the behavior of individual students. Use of teacher ratings of classroom behavior may have introduced potential bias resulting from the teachers' general feelings about recess. In addition, no data were available regarding the amount of physical activity during the recess periods. Overall, this is the only large-scale study on the effects of short bouts of physical activity on classroom behavior. The study provides evidence that suggests that recess breaks have a small effect on teachers' ratings of classroom behavior.

Jarrett et al. (1998) directly observed classroom behavior in fourth grade students ($n = 43$) to determine if recess breaks were related to on-task behavior, fidgety behavior, and listless behavior. For this study, they introduced recess into a school that did not normally schedule recess. Students in two fourth grade classrooms were randomly assigned to have recess on one day and no recess on the other day. One classroom was observed for 25 min before and after recess and for 25 min before and after math/science instruction. Both recess and instruction lasted for 15 to 20 min. Students in the second classroom were observed for 20 min after recess and for 20 min after instruction. Students in this classroom were not observed before recess or instruction. Such limitations are not unusual in school-based research.

Students were observed for 5-second intervals and the appropriate behavior code was then circled. The behavior score was the cumulative percentage of time spent performing the given behavior (i.e., time on-task, fidgety, or listless). Jarrett et al. (1998) documented acceptable interrater reliability (e.g., percentage of agreement ≥ 0.88), which is a necessary step for direct observation studies. On-task behavior was significantly increased (90% vs. 85% on-task behavior) and fidgety behavior was significantly decreased (7% vs. 16% fidgety behavior) on recess vs. non-recess days. Cohen's delta (ES) values were calculated from the data provided in the article and demon-

strated that differences in on-task behavior were of medium size ($ES = 0.51$) and differences in fidgety behavior were large ($ES = 0.94$). Listless behavior was recorded relatively rarely and was not affected by recess.

Pellegrini et al. (1995) conducted a series of experiments in which classroom behavior was directly observed. In Experiment 1, kindergarten students were observed while working at interest centers for 20 min before and 20 min after a 20-minute recess period. Second and fourth grade students were observed while they listened to a story read by the teacher for 20 min before and 20 min after a 20-minute recess period.

The researchers used scan sampling and instantaneous recording. Thirty-second scans were made and each child was observed within that scan. Whatever the child was doing at the instant he/she was observed was recorded. Inattention was determined by the direction of the child's gaze. If the child was not looking directly at the teacher during the book reading, then inattention was coded. This definition of inattention can be questioned because it is quite possible that a child can pay attention when not looking directly at the teacher. However, the authors reported adequate interobserver reliability for their measure of inattention-to-task (Cohen's kappa > 0.75 for all experiments).

In Experiment 1, the relative frequency of inattention-to-task was significantly improved post-recess compared to pre-recess for second (decreased by 8.4%; $n = 24$) and fourth grades (decreased by 1.7%; $n = 21$), but the difference for kindergarten students was not significant (decreased by 0.8%; $n = 17$). Experiment 2 was a replication of Experiment 1 with second ($n = 22$) and fourth grade ($n = 15$) students. In this experiment, a significant improvement in inattention-to-task was apparent for second grade students (decreased by 1.8%), but not for fourth grade students (decreased by 0.4%). For Experiment 3, two second grade classrooms were observed during indoor recess, which represented a relatively sedentary break period. Again results were mixed. A significant improvement in inattention-to-task was observed for one classroom (decreased by 1.3%), but not for the other classroom (decreased by 0.9%).

In all experiments children had improved inattention-to-task post-recess vs. pre-recess, but only 4 of 7 comparisons were statistically significant. Similar results were found with outdoor and indoor recess. Unfortunately, standard deviations of inattention-to-task were not reported so that it was not possible to calculate effect sizes.

Grieco et al. (2009) examined the effects of physically active classroom lessons and body mass index (BMI) on time-on-task. Third grade students ($n = 97$) participated in an active lesson and in an inactive control lesson. Time-on-task was assessed through momentary time sampling using 5-second observation intervals. Although interobserver reliability was not estimated as part of the study data collection, the researchers demonstrated high levels of agreement (percentage of agreement > 90%) among the three observers before the study and at a 3-month follow-up assessment. Participants were examined for a total of 15 min before and after the lessons. Results demonstrated small, non-significant improvements in time-on-task following the active lesson for all BMI categories (ES ranged from 0.13 to 0.26). Significant decreases in time-on-task were found for students in all BMI categories following the inactive control lesson. The decline in time-on-task following the inactive lesson was greater for overweight participants ($ES = -1.28$) and at risk for overweight participants ($ES = -0.68$) than for normal weight participants ($ES = -0.39$). The authors recognized that observation for only 15 min following the lesson was a limitation that could have underestimated the effects of a physically active lesson on time-on-task. They concluded that physically active academic lessons may prevent the reduction in time-on-task seen after traditional inactive lessons, particularly for students who are overweight.

Overall, these studies, taken together, provide limited evidence that short activity breaks improve subsequent attention-to-task. The

limitation of the large scale study by Barros et al. (2009) was that attention-to-task was not directly observed, rather group classroom behavior was reported via teacher questionnaire. Jarrett et al. (1998) directly observed attention-to-task following recess and found meaningful improvements in classroom behavior. Pellegrini et al. (1995) reported mixed results, but their measure of attention-to-task (i.e., if a student's gaze was not directed at the teacher who was reading a story, then the student was considered off-task) may have limited validity. Although improvements in time-on-task following a physically active academic lesson were not statistically significant (and effect sizes were small) in the study by Grieco et al. (2009), they demonstrated significant declines in time-on-task following inactive lessons and suggested that the beneficial effect of physically active academic lessons might be more apparent for overweight than for normal weight children.

Effects of Energizers on on-task behavior

Mahar et al. (2004) developed classroom-based physical activities, called *Energizers*. *Energizers* are short classroom-based physical activities for grades K-5 that provide opportunities to increase daily physical activity in school. *Energizers* are led by classroom teachers in their classroom, take approximately 10 min to perform, and integrate academic content. Because *Energizers* integrate academic content and have been shown to improve classroom behavior (Mahar et al., 2006b) they have been widely adopted. Evenson et al. (2009) reported results of a survey that suggests that over 70% of elementary school teachers in North Carolina use *Energizers* at least twice a week. Be Active North Carolina, Inc., a non-profit organization that promotes regular physical activity for all North Carolinians, used a train-the-trainers model that reached over 41,000 teachers in the state to prepare them to lead *Energizers* in their classrooms. Mahar et al. (2006a) subsequently developed activities for middle-school students.

Mahar et al. (2006b) evaluated the effectiveness of the *Energizers* classroom-based physical activity program on elementary school-aged children's on-task behavior during academic instruction time. They conducted a 45 minute training session to prepare teachers to lead the *Energizers* activities. During the training session, teachers were instructed on the importance of physical activity for children and how to use *Energizers* to lead activities in their classrooms. Teachers were provided with *Energizers* booklets and then practiced leading and performing sample *Energizers* activities. Third and fourth grade teachers were also told about the direct observation of on-task behavior that would occur in their classrooms, when to begin the *Energizers* activities in their classrooms, and how the observers should be treated.

School day physical activity was assessed on all K-4th grade students and on-task behavior was assessed on two third grade ($n = 37$) and two fourth grade ($n = 25$) classes. Kindergarten through fourth grade students wore pedometers during the school day for 1 week. Two of three classes for each grade level were randomly selected to serve as intervention groups.

The intervention groups performed *Energizers* activities as led by their classroom teachers, received a pedometer log card, and recorded steps before and after *Energizers* and at the end of the school day. Control groups received a pedometer log card and recorded steps at the end of the school day, but did not perform *Energizers* activities. The mean number of steps taken during the school day by the intervention group (5,587 steps) that performed the *Energizers* activities was significantly and meaningfully greater than the mean number of steps taken by the control group (4,805 steps). The intervention group took 782 more daily in-school steps than the control group, which, over the course of a 180 day school year, can be quite substantial. Assuming students average two feet per step, participation in one *Energizers* activity per day would be equivalent to moving over 70 more miles per school year.

Although teachers are interested in the health of their students, the variable that speaks most compellingly to teachers, and seems

closely related to their job description, is on-task behavior. Teachers appear to understand intuitively that if their students are more on-task, the students will be better behaved in class and more likely to perform well on academic work. Thus, demonstrating that incorporation of physical activity into the classroom improves on-task behavior has the effect of motivating teachers to use physical activity as a teaching tool.

In the Mahar et al. (2006b) study, two third grade and two fourth grade classes were randomly selected to serve as intervention groups in the on-task behavior portion of the study. Data collection lasted 12 weeks and a multiple baseline across classrooms design was used. Baseline lasted 4 weeks for two classes and 8 weeks for two classes. At baseline, students were observed during instruction time before and following the break in observation. The break in the observation simulated the place of the *Energizers* activity that would occur during the intervention. For the intervention, teachers began using *Energizers* activities after 4 weeks or 8 weeks of baseline. Students were observed during instruction time before and following the *Energizers* activity.

Observation of on-task behavior was conducted by two primary and two secondary observers. Two 30-minute observation periods were conducted per class each day. During the 30-minute observation periods, six students were observed for 5 min. Observation intervals lasted for 10 s and record intervals lasted for 5 s. After one minute of observation, the observers rotated to the next student to be observed. A prerecorded audio file was used to indicate when to observe and when to record. Behavior codes were: on-task, off-task noise, off-task motor, or off-task other. The three off-task codes were condensed to off-task for analysis.

Following recommendations of Van Houten and Hall, (2001), observers were thoroughly trained before conducting observations. In the training sessions, observers learned definitions of on-task and off-task behavior and watched training videos to practice observing. Specific incidents of behavior were discussed by the observation team. Observers were trained until definitions were learned and at least 80% reliability was achieved between observers. Observers then practiced observations in actual classrooms for 1 week prior to data collection. The mean percentage of agreement for on-task behavior throughout the study was 94%.

Analysis of on-task behavior was carried out by developing and interpreting graphs of baseline and intervention periods and then conducting a two-way (time [pre-observation vs. post-observation] $\times$ period [baseline vs. intervention]) repeated measures ANOVA. A sample graph of observation data for one class is provided in Fig. 1. The graph demonstrates an inconsistent pattern during baseline with post-break on-task behavior greater than, less than, or similar to pre-break on-task behavior depending on the week. It is important to demonstrate no timing effect or a negative effect of timing (e.g., lower on-task behavior during post-break compared to pre-break) before introducing the intervention in order to later determine if the intervention had an effect. The graph then shows that during the intervention, which for this class lasted 8 weeks, on-task behavior was consistently greater after the *Energizers* activity compared to before the activity.

Table 2 presents data that demonstrate a significant and meaningful improvement in on-task behavior after students performed an *Energizers* activity compared to before the activity ($ES = 0.62$), but no significant change in on-task behavior during baseline when no *Energizers* activity was performed ($ES = -0.20$). An even stronger effect was seen, for the students who were the least on-task at baseline. This indicates that the effect of the *Energizers* activities on on-task behavior was stronger for the students who needed it the most – those who were the least on-task at baseline.

Mahar et al. (2006b) concluded that a classroom-based physical activity program (i.e., *Energizers*) was effective for increasing physical activity levels of children in grades K-4 and for improving on-task behavior in 3rd and 4th grade students. They recommended that

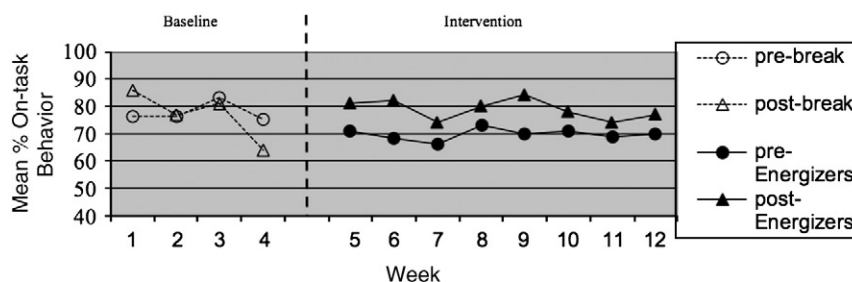


Fig. 1. Mean percentage of intervals of on-task behavior during baseline and intervention for one fourth grade class.

Reprinted with permission from Mahar et al., 2006b. Effects of a classroom-based program on physical activity and on-task behavior. *Medicine and Science in Sports and Exercise* 38, 2086–2094.

Table 2

Percentage (SD) on-task behavior among third and fourth grade students ($n = 62$) and among least on-task students ($n = 10$) during baseline and intervention periods.

	Baseline Period		Intervention Period	
	Prebreak	Postbreak	Pre-Energizers	Post-Energizers
All Participants	71.3 (16.3)	68.2 (14.5)	70.9 (15.2)	79.2 (11.4)
Least On-task Students	57.0 (15.6)	55.3 (8.7)	46.1 (7.1)	66.0 (11.3)

Table developed from data presented in: Mahar, M.T., Murphy, S.K., Rowe, D.A., Golden, J., Shields, A.T., Raedeke, T.D., 2006. Effects of a classroom-based program on physical activity and on-task behavior. *Medicine and Science in Sports and Exercise* 38, 2086–2094.

elementary teachers who want to increase physical activity levels and/or on-task behavior in their students consider using *Energizers* activities.

Summary

In summary, the measurement of attention-to-task is intensive and demanding. Substantial training and re-training of observers is essential to obtain credible data and a good working relationship with the school staff is critically important. Attention-to-task is a variable that speaks directly to the concerns of teachers. Demonstrating that physical activity performed in the classroom can increase on-task behavior can motivate teachers to incorporate physical activity into their daily lessons. Evidence is moderate to good that physical activity incorporated into the school day can improve attention-to-task and teachers can be trained in a relatively short amount of time to effectively lead such activities.

Conflict of interest statement

None.

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