



Acute classroom exercise breaks improve on-task behavior in 4th and 5th grade students: A dose–response



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ABSTRACT

This study was the first to directly compare the acute effects of 5, 10, and 20 min of classroom exercise breaks on on-task behavior.

Methods: In this within-subject experiment, 96 4th and 5th grade students, in 5 classroom groups, participated in each of four conditions: 10 min of sedentary classroom activity and 5, 10, 20 min of classroom exercise breaks led by research staff. On-task behavior was directly and systematically observed from videotapes before and after each condition. The post-test time-on-task scores were compared using a repeated measures mixed ANCOVA, adjusted for age, classroom, and the time-varying pre-test time-on-task.

Results: Time-on-task was significantly higher in students after 10 min of classroom exercise breaks compared to a sedentary attention control (87.6% vs 77.1%, $d = .45$, $p = .004$).

Conclusions: Ten minutes of classroom exercise breaks improved on-task behavior in children.

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Many factors influence students' performance in school and on standardized academic tests (Best & Miller, 2010; Dollinger & Clark, 2012; Duckworth, Quinn, & Tsukayama, 2012; Rowe, Miller, Ebenstein, & Thompson, 2012). One large influence on academic achievement is student on-task behavior and attention (Frazier, Youngstrom, Glutting, & Watkins, 2007; Rudasill, Gallagher, & White, 2010). Thus to improve academic achievement, many teachers and interventions have aimed to increase on-task behavior or time-on-task (Amato-Zech, Hoff, & Doepke, 2006; Hawkins & Axelrod, 2008; Riley, McKevitt, Shriver, & Allen, 2011). Emerging evidence suggests that one way to increase on-task behavior is through increasing physical activity opportunities during the school day (Grieco, Jowers, & Bartholomew, 2009; Mahar et al., 2006; Pellegrini, 1995, pp. 845–864; Pellegrini & Davis, 1993). Physical activity in children has been shown to improve neuro-electrical activity (Hillman, Kamijo, & Scudder, 2011) attention and inhibitory control (Drollette, Shishido, Pontifex, & Hillman, 2012)

which help students to rule out distractions and focus on the task. When researchers have objectively observed on-task behavior in relation to recess, they found that students are more on-task after recess (Jarrett et al., 1998; Pellegrini, 1995, pp. 845–864). Attention and the ability to inhibit distracters, which both contribute to on-task behavior, have both been shown to improve after an acute bout of physical activity in children (Drollette et al., 2012; Hillman, Buck, Themanson, Pontifex, & Castelli, 2009). Additionally, an observational study found that teachers report better classroom behavior in schools where students have greater amounts of recess (Barros, Silver, & Stein, 2009).

Unfortunately, adding physical activity to the school day can be difficult due to the competing priorities, budget concerns and lack of time reported by teachers and administrators (Center on Education Policy, 2011; Cox et al., 2011). Classroom exercise breaks, short bouts of physical activity integrated within the school day, provide a low-budget and feasible way to increase physical activity in students. Components of Take 10!, an example classroom exercise break curricula, have been integrated into numerous interventions, and have had a generally positive effect on educational and health outcomes (Kibbe et al., 2011).

Few studies, however, have examined the acute effects of these short exercise bouts on on-task behavior in children. Mahar et al. observed on-task behavior before and after a classroom exercise break and found that on-task behavior increased by 8 percent after

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the exercise (Mahar et al., 2006). Another study found that exercise breaks can help students maintain on-task behavior (Grieco et al., 2009). Little is known on the optimal dose of these classroom exercise breaks. Kubesch et al. found positive cognitive effects after 20 min of physical education but not after 5 min of a classroom exercise break (Kubesch et al., 2009). To our knowledge, no study has directly compared different durations of classroom exercise breaks on on-task behavior or attention.

Also unknown are the differential effects of classroom exercise breaks between classrooms and individual students. In the two studies to observe on-task behavior after classroom exercise breaks, both found that the effects were different based on student characteristics (Grieco et al., 2009; Mahar et al., 2006). In those studies, the effects of classroom exercise were the most beneficial in those with attention difficulties (Mahar et al., 2006) and with higher body mass index (Grieco et al., 2009). Other individual differences in responses have not been examined. These variations in response can be lost when results are examined in unstratified groups.

The purposes of this experimental study were to determine the acute effects of classroom exercise breaks on on-task behavior in elementary school students and to examine the differences in responses between 5, 10 and 20 min of exercise. Additionally, the effects were examined by individual classrooms and several individual student factors including gender, intelligence quotient (IQ), fitness, fatness, behavior, school engagement and baseline on-task behavior.

1. Methods

1.1. Participants

A convenience sample of a school and classrooms was selected through agreement of the principal and teachers. Participants ranged from 9 to 12 years of age and were 4th or 5th grade students in one elementary school in South Carolina. All students from eight participating classrooms were invited to participate. Classrooms in the school were grouped on the basis of academic abilities and interests. To efficiently administer the intervention to consenting students, some classes were combined and the intervention was delivered to five classroom groups.

1.2. Procedures

This study used a within-subjects experimental design with students exposed to each of four conditions: 10 min of seated classroom activity and 5, 10, 20 min of classroom exercise breaks. The order of conditions was randomized to each classroom group, with students participating in one condition per week, using a Latin Square design, to counterbalance practice effects (Shadish, Cook, & Campbell, 2002). Time-on-task was measured before and after each condition while the students performed pencil-and-paper tasks. This pre-post design was used to account for daily variation in time-on-task. To familiarize students with the classroom exercise breaks, thus reducing novelty effects, students participated in two days of classroom exercise breaks per week. Time-on-task was only observed on one day a week. All observations were held on the same time and day of the week for each classroom group. Parent consent and student assent were obtained for all participants.

1.3. Treatments

The Brain BITES (Better Ideas Through Exercise) exercise break intervention was led by research staff twice a week for the 4-week study duration. The exercise breaks were designed to maintain moderate-to-vigorous physical activity and to be fun and engaging

for the students. Specific exercises were selected to be feasible within a small classroom setting and included marching in place with arm movements, various forms of jumping, and running in place. Exercise sessions were performed to music selected by the students in a brief planning session prior to the intervention and the instructor verbally encouraged as well as physical participated in all sessions. To further encourage participation, the instructor encouraged students to get their heart rates to 150 beats per minute. Students recorded their own self-palpated carotid or radial pulse rates immediately after each session.

Activities were similar across the four exercise conditions; only the duration of activities varied. All intervention conditions were videotaped and coded for physical activity intensity. The three exercise durations were 5, 10, and 20 min of classroom exercise breaks. These durations were selected because research has found acute effects in similar outcomes with 10 and 20 min of physical activity (Hillman, Pontifex, et al., 2009; Mahar et al., 2006). Limited evidence has shown that briefer periods of physical activity may not be sufficient to elicit acute improvements in cognitive functions (Kubesch et al., 2009), however, for feasibility and sustainability, briefer sessions are more likely to be implemented and integrated within busy classroom schedules.

1.4. Measures

Baseline measures were administered prior to the intervention. Standardized height and weight were used to calculate Body Mass Index (BMI). Participating students completed the 15 m PACER test from the FITNESSGRAM battery as an estimate of aerobic fitness. Students were individually administered the Kaufmann Brief Intelligence Test-Second Version (KBIT-2) as a measure of abbreviated IQ. Additionally, students completed a brief survey on their previous academic grades, physical activity levels (Eaton et al., 2010), and engagement in school (O'Farrell & Morrison, 2003). Parents completed a brief survey on parent education, race and socioeconomic status. They also completed the Conners' Parent Rating Scales Revised short edition, a 27 item checklist to assess attention-deficit/hyperactivity and problem behavior symptoms.

1.4.1. Physical activity intensity

To assess the fidelity of the intervention, videotapes of all four conditions were coded for intensity of physical activity using a modified System for Observing Fitness Instruction Time (SOFIT) as modified by Donnelly (McKenzie, Sallis, & Nader, 1992). Observations were made of individual children at consecutive 10-s intervals during the exercise or sedentary condition, not including cognitive testing. Their average activity level during the 10-s interval was coded using a scale from 1 to 5 where 1 is equal to lying down and 5 is equal to being very active (ex. running in place, jumping). Videos were viewed and coded three times with a different child observed for the same intervals during each viewing. Each participant was observed an average of 16.8 times during the sedentary condition, 7.5 times during the 5-min exercise break, 12.5 times during the 10-min break, and 25.5 times during the 20-min break. To assess reliability, ten percent of the intervals were recoded four months after the initial coding ($n = 424$). Intervals were randomly selected in groups of 10. The percent agreement was 91.0% with a weighted kappa of .95.

1.4.2. Time-on-task

To obtain an ecologically valid measure of time-on-task, children were directly observed as consistent with previous studies (Mahar et al., 2006; Pellegrini, 1995, pp. 845–864). A systematic time sampling observation system was used. Multiple observation intervals of time-on-task have been used ranging from 10 s (Mahar

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