Brain Breaks and On-Task Behavior: Single Subject Study

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The purpose of this study was to research the effects of brain breaks, as implemented in a classroom setting, on the on-task behavior of students in an attempt to validate a more time-and cost-effective solution to students’ lack of focus in the classroom. The participants were three third-graders with and without ADHD who attended a public school in North Texas. During the study, the participants participated in 5-10 minute physical activity brain breaks. Visual analysis of the data indicated that the brain break intervention was effective at increasing on-task behavior. Results are discussed in terms of trend, level, variability of data, and percentage of non-overlapping data (PND).
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Brain Breaks and On-Task Behavior: Single Subject Study

Interest on whole-brain teaching has been growing rapidly within the past decade. The concept that learning is not simply a mental skill, but also encompasses movement and the senses is slowly being developed and researched (Dennison, 2010). Since children spend the majority of their day at school, the school environment is an appropriate setting in which to incorporate brain breaks, short physical activity breaks from the classroom curriculum, and provides a good setting for children to be physically active (Mahar et al., 2006).

Unfortunately, as Mahar et al. (2006) explained in their study, that physical activity in and out of the classroom has been scrapped in light of reductions in school funding and increasing pressure to increase academic achievement. The Center for Disease Control and Prevention (2010) stated that in 2006 only 4% of the U.S. elementary schools provided physical education everyday for all students in all grades. The withdrawal of recess gives students limited opportunities to be active.

Without an outlet to release energy and re-charge for the next lesson, students are having a difficult time focusing in the classroom (Jarrett et al., 1998). This deterioration of focus may cause academic scores to fall over time. This study was conceptualized in light of current research on the positive effects of physical activity. The purpose of this study is to research the effects of brain breaks, as implemented in a classroom setting, on the on-task behavior of students in an attempt to validate a more time-and-cost effective solution to students’ lack of focus in the classroom.

When a school cannot provide physical education or recess, a great alternative is a small physical activity break. Jarrett et al. found that children focus more and fidget less when they received recess versus when they did not have recess. A study conducted by Erwin, Beighle,
Morgan, and Noland (2011) also found that children were more focused immediately after recess than they were before. Teacher-directed classroom-based physical activity interventions can improve student physical activity, on-task behavior and academic skills (Erwin et al., 2011; Hoza et al., 2014; Mahar et al., 2006).

**Brain and Physical Activity Theories**

The idea of whole-brain teaching incorporates movement and the senses. Theories from the past shed light on the workings of whole-brain teaching and short physical activity breaks. The oldest notion is that of the surplus energy theory. Herbert Spencer, an English Philosopher, proposed this theory in 1898. This theory suggests that there is a surplus of energy that accumulates when one is sedentary for a long amount of time. Physical activity is needed to “blow off steam” to use up the surplus energy (Jarrett et al., 1998, p 122).

A more modern theory is the novelty-arousal theory. This theory suggests that people function better when they have a change of pace, such as a quick break from a classroom lesson. A cognitive difference exists between learning for an extended amount of time versus spaced practice. Memory recall was tested using this theory and resulted in improved memory recall with the use of spaced learning rather than extended learning (Jarrett et al., 1998).

**Academic Achievement**

Studies have consistently demonstrated that physical activity is associated with improved cognitive skills, academic achievement and academic behavior (GoNoodle, 2012; Hollar et al., 2010). These findings spur the notion that physical activity and classroom academics do not need to compete for time in the school day. One study reported on the effects 10-15 minute physical activity breaks on Body Mass Index (BMI) and academic achievement. The participants were 1,197 elementary-aged students in Florida. Students in the intervention group scored higher on
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their Florida Comprehensive Achievement Test (FCAT) math scores than the students in the control group (Hollar et al., 2010).

High academic achievement is hard to obtain especially for students with disabilities, such as Attention-Deficit/Hyperactivity Disorder (ADHD; Cook et al., 2014). “ADHD is a chronic neurodevelopmental disorder. It is characterized by symptoms of inattention and hyperactivity/impulsivity and is linked to impairment in multiple domains (school, home, peer functioning)” (Hoza et al., 2014, p. 1). Students with ADHD are often prescribed medication to compensate for the symptoms of ADHD (Cook, Bradley-Johnson, & Johnson, 2014; Hoza et al., 2014; Jensen, & Kenny, 2004). Yet, 25% of students with ADHD remain off-task in the classroom and may fail to improve academically even while taking medication (Cook et al., 2014). The importance of promoting on-task behavior is integral to supporting students with disabilities.

**On-Task Behavior**

On-task behavior has been linked to improved academic achievement and student grades. Poor on-task behavior is a problem in the school setting because many students have difficulty staying focused. On-task behavior as it applies to this study is defined as a student sitting in their chair, engaged in assigned work (reading, writing, raising hand, cooperative learning), and eye contact with teacher when the teacher is speaking.

By allowing a release of energy and a mental change, a physical activity break may promote students to be more attentive to their academic tasks and less restless in the classroom immediately after the break (Jarrett et al., 1998; Mahar et al., 2006). Physical activity, such as recess, may be a supportive element to successful classroom management. Findings in the study
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conducted by Barros, Silver, & Stein, (2009) suggest that recess may create a positive outlook on whole-class behavior.

Some children are often distracted and do not have the learned skills needed to maintain attention to an activity (Cardona, Martinez, & Hinojosa, 2000; Cook et al., 2014; Hoza et al., 2014; Jensen et al., 2004; Ridgway, Northup, Pellegrin, LaRue, & Hightsoe, 2006). These students may also have an extremely hard time staying sedentary throughout the school day. Students with ADHD have difficulty attending to tasks and have poor concentration when they don’t have the opportunity to re-focus their energy on the subject at hand (Jarrett et al., 1998).

On-Task Behavior for Students with ADHD

Students with disabilities, specifically ADHD, tend to have a harder time staying on-task and need outlets to release their energy in order to stay on-task (Jarrett et al., 1998; Jensen et al., 2004; Mahar et al., 2006; Ratey, 2008, Ridgway et al., 2006). Post-exercise students are calmer and more focused (Ratey, 2008). One study examined the effects of recess on 43 students in fourth grade. Five of the students had a diagnosis of ADD. The results of the study showed that 60% of the children benefited from the recess break. The five children with ADD showed improvement in on-task behavior and became less fidgety (Jarrett et al., 1998).

The use of yoga outside of the school has also proved to be a helpful form of physical activity for students with ADHD. A study conducted by Jensen et al. (2004) used the Conners’ Teacher Rating Scale to measure behavioral problems such as: cognitive problems, hyperactivity, social problems, and ADHD before and after the intervention of yoga. The students who received the yoga intervention reported significant differences between pre and post-test results.
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Another study examined the effects of 10-minute recess breaks for students with and without ADHD. The researchers noticed that the inappropriate behavior (off-task behavior) increased when the students were not provided with recess and became more severe on weeks where they continued without recess. The percentage of inappropriate behavior on days without recess for the peer group was 37%. On days with recess, the percentage of inappropriate behavior decreased to 21%. All three students with the diagnosis of ADHD benefited from the 10-minute recess intervention (Ridgway et al., 2006).

Even with the evidence-based research in these studies, some districts do not have the money to pay for physical education teachers. Moreover, more than one recess break per day may take away from time spent on academic learning in the classroom (Barros et al., 2009; Erwin et al., 2011; Jarrett et al., 1998; Mahar et al., 2006; Ridgway et al., 2006). Taking physical activity into the classroom can increase the likelihood that students get their much-needed breaks during the day. A study by Mahar et al. (2006) implemented energizer breaks, 10 minute teacher-led activity breaks, to increase on-task activity in the classroom. This short and low-cost physical activity break increased mean on-task behavior by 8% and for the least on-task students, their on-task behavior increased by 20%.

**Brain Breaks**

Recent studies (Erwin et al., 2011; Hoza et al., 2014; Mahar et al., 2006) investigated the effect that physical activity breaks have on student on-task behavior and decreasing symptoms of ADHD. The focus of these studies is on the impact of a short, inexpensive physical activity break and its affect on students’ classroom behavior. These prior studies implemented a range of physical activity breaks (before-school and during school). The results of these studies were
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successful, increasing on-task behavior as well as behaviors that are symptoms of ADHD through different forms of physical activity.

Mahar et al. (2006) states, “Children often are more attentive, behave better, and perform as well or better scholastically after participation in physical activity” (p. 2086). The short physical activity used in this study was a form of brain break. A brain break is a physical activity break from the classroom curriculum; students get the opportunity to move around the room and let out some of their stored energy.

The brain break intervention proposed for this study is a product called GoNoodle created by HealthTeacher, Inc. These cost-free technology-based breaks are designed to last only a few minutes of classroom time (GoNoodle, 2012). The use of technology in the classroom has generated an increase in children’s curiosity, attention span, and concentration (Cardona et al., 2000). The students’ become re-engaged in the topic in that short time, maximizing class-time (GoNoodle, 2012). This single subject study aims to evaluate the effectiveness of brain breaks with elementary school students with and without ADHD to improve on-task behavior. The goal of this study is to see if a functional relationship exists between the implementation of brain breaks and on-task behavior.

Methods

Participants

Three third-grade students from a public school in North Texas participated in the study. The three students were teacher recommended and met the inclusion criteria: poor on-task behavior, as defined by, engaging in off-task behavior for a minimum of 10 instances within a one-hour observation. The teacher described the students as having a difficult time staying on-task during the school day. She felt that the students could benefit from extra physical activity
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without taking away from class time. All students participating in the study were eight to nine
years of age and in the third-grade. One student was diagnosed with Attention
Deficit/Hyperactivity Disorder (ADHD) and was on medication, a second student had a hearing
impairment and an Individualized Education Plan (IEP), and the third student was typically
developing. The participants are all from medium to high SES backgrounds and are Caucasian.
These students had a once daily 25-minute break for recess after lunch.

Setting
All baseline and intervention data collection sessions took place in a general education
third-grade classroom. The classroom had a cooperative-learning layout with clusters of three to
four desks in a group. The classroom consisted of 23 students who demonstrated a great range of
ability. The brain break intervention, GoNoodle, took place at the front of the classroom on the
SMART board while the children followed along next to their desks by mimicking the yoga
moves that were shown on the board. A SMART board is an interactive white board that allows
the computer to work as a whiteboard, computer and a projector. During baseline, data collection
took place during the daily science lesson. During the intervention phases, data collection took
place after the GoNoodle session, once the students returned to their desks for their science
lesson. At the time of this study, the classroom had one lead teacher and two special education
teachers who would intermittently assist students during the day. The lead teacher has a graduate
degree in Educational Leadership and the two special education teachers are special education
certified.

Materials and Procedures
The materials used to collect data were a stopwatch and a data collection sheet. Prior to
the implementation of brain breaks, baseline data were collected once a day for 20 minutes, 1:40
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p.m. to 2:00 p.m., Tuesday through Friday. Data were collected for on-task behavior. Operationally defined, on-task behavior was defined as a student sitting in his or her chair, engaged in assigned work (reading, writing, raising hand, cooperative learning), and making eye contact with the teacher when the teacher was speaking. During the implementation of the intervention, brain breaks, no quantitative data were collected. After math, the students put away their materials, they stood up, pushed in their chairs and stood ready for the brain break on the SMART board. The brain break intervention consisted of a 5-10 minute session of yoga lead by the internet character on GoNoodle. Once the brain break was over and all students were back in their seat, the intervention was considered finished for the session. Post-intervention, when the students returned to their desks, data were collected. Data collection took place at the same time everyday.

Inter-observer reliability was collected during this study. Both researchers were graduate students in education. Reliability was calculated by dividing the number of agreements for on-task behavior by the number of agreements plus the number of disagreements. The number is multiplied by 100 to find the percentage. During the study, the second researcher conducted observations for 23.5% of the total observations. The mean percentage of agreement for on-task behavior was 89.6%.

To maintain procedural fidelity, all students participated in the brain break activity for each session of the intervention. The intervention and data collection took place at the same time every session. The procedural fidelity checklist was used with each session to make sure the teacher implemented the intervention correctly. To view the checklist used see Appendix A. Once all students returned to their seats, data collection began.
Measures

The researchers measured on-task behavior through momentary time sampling. The time sampling data collection method consists of setting an interval of time, in this study it was one minute. If the behavior occurs when the researchers look up at the end of one minute, the on-task behavior is recorded. The observations and data collection occurred every minute post-intervention. The researchers would scan the room at the end of every minute and mark if the three participants were on or off-task during that point in the interval. This process was repeated throughout the observation hour. To ensure reliability for the measurement of the dependent variable of on-task behavior, the researchers collected data at the same time and on the same days for baseline and intervention conditions. The researchers graphed the data collected.

Research Design

For this study, an A-B-A-B reversal research design was used to determine the effectiveness of the intervention of brain breaks to improve on-task behavior. The use of this particular design allows for efficient measurement of individual changes in behavior following an intervention. In this research design, data collection was separated into four phases. In the first phase, baseline data were collected at the same time every day, over the span of four days. During the intervention phase, data were collected on the same times and days after using the brain break intervention. During the return to baseline phase, brain breaks were withdrawn and data were collected the same way as the previous baseline phase. During the second intervention phase, data were collected on the same time and days after using the brain break intervention.

The purpose of a reversal design was to see first, whether or not there was a change in the student behavior once the intervention was introduced, and second whether or not the
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intervention was responsible for that change. Following the intervention phase, the intervention was withdrawn, or removed, after the data had stabilized, and data were collected for a second time in the baseline condition. After data stabilized during the second round of baseline, the intervention was reintroduced to serve as an intra-subject replication of its effect.

This type of research design supports the internal validity of the study. An A-B-A-B reversal research design helps to build internal validity because the intervention is removed and reinstated to serve as a replication of results. Since this was a single subject study it is difficult to generalize the results to larger populations. However, by using a reversal method and removing the intervention as well as reintroducing the intervention, and generating the same results, this serves as a replication for the study and helps build internal validity. Using the A-B-A-B design, any immediate change seen in the data across conditions, while controlling for other variables, shows that the brain break intervention was responsible for the change in behavior.

**Data Analysis**

The data collected for this single subject study are displayed on a line graph in order to show the increase and decrease in on-task behavior across conditions. The data were analyzed visually through the different aspects of trend, level, stability and percentage of non-overlapping data (PND) to establish whether or not a functional relationship existed between brain breaks and on-task behavior. The trend of the data illustrates direction of data within conditions. The trend can be zero-celerating (no change in direction), decelerating (moving downward) or accelerating (moving upward). Although trend is calculated within conditions, it is compared across conditions. The question being, “Does the trend of data change across conditions? And, if so, in what direction?” The level of the data is the average of the data points in the given condition. Changes in level inform the researcher about the relative impact of the intervention on
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the baseline behavior. Variability refers to the layout of the data points within a condition. If the points stay steady, then the data is said to be fairly stable and have little variability. If the points are more sporadic or spread out, the data is said to have higher variability. A condition change is introduced once the data show little variability. Finally, the PND of the data is the percentage of data points collected between conditions that do not overlap. All four of these analyses were conducted in the baseline and intervention phases. In order for a functional relationship to exist between on-task behavior and the brain break intervention, a significant increase in on-task behavior from baseline to intervention, as measured through level and trend differences, has to be present (when all other variable are controlled). Also, a decrease in on-task behavior had to occur when the brain break intervention was withdrawn and baseline conditions were reestablished. PND will support this relationship if the PND is found to be large. Data are reported in percent because the data intervals varied from session to session. Therefore all data in this study are reported in percentages so they can be directly compared. In order to measure the participants’ satisfaction of the intervention, a student questionnaire (see Appendix B) was used with a five-point Likert scale.

Results

Results of Interobserver Reliability Analysis

Interobserver reliability was calculated by dividing the number of agreements on occurrences of on-task behavior and off-task behavior by the total number of observation intervals. The number was multiplied by 100 to obtain a percentage of agreement between observers. During the study, a second observers conducted observations for 23.5% of the total observations. The mean percentage of agreement for on-task behavior was 89.6% (range of
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agreement = 84-100%). Percentage of higher than 84% denotes non-bias and data collection objectivity.

**Procedural Fidelity**

Procedural fidelity was measured for 22% of the sessions using a procedural fidelity checklist. The second researcher used this checklist to collect data on procedural variables and report the percentage of times that each procedure was correctly followed. Procedural fidelity is calculated by dividing the number of observed behaviors by the number of planned behaviors multiplied by 100 (Gast, & Ledford, 2014, p.94). Procedural fidelity was calculated at 100%.

**Student A**

The collected data for Student A’s on-task behavior across baseline and intervention conditions are presented in Figure 1. During baseline condition, there was a small decelerating trend in Student A’s on-task behavior. The calculated variability of baseline data indicated that 50% of points fell within the stability envelope (20% of median). Since baseline data were stable across four collection sessions, the intervention of brain breaks was implemented. Implementation of the brain breaks showed a significant level change between baseline and intervention conditions. This is a significant and abrupt change because there is a large change from baseline to intervention. The relative level change seen across these conditions was 38.9% in the desired direction. The trend in the intervention phase data was accelerating, as determined through visual analysis. The PND between baseline and intervention was 100%. A PND of 100% indicates that none of the data points across conditions overlapped one another. Little variability of data was evident in the first intervention phase; 60% of the data points fell within the 20% stability envelope of the median point. Since 60% of the data points were stable, the baseline
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conditions were reinstated as an attempt to replicate results. Student A rated the intervention using the 5-point Likert scale, on the student questionnaire, a 4.5 and this student said they enjoyed the energy of the brain break and the songs used.

Student B

The collected data for Student B’s on-task behavior across baseline and intervention conditions are presented in Figure 2. During baseline condition, there was a decelerating trend in Student B’s on-task behavior. The calculated variability of baseline data indicated that 25% of points fell within the stability envelope (20% of median). Since baseline data were mostly stable across four collection sessions, the intervention of brain breaks was implemented. Implementation of the brain breaks showed an absolute and abrupt level change between baseline and intervention conditions. The relative level change seen across these conditions was 37.5% in the desired direction. The trend of the data in the intervention phase was accelerating. The PND between baseline and intervention was 100%. Little variability of data was evident in the first intervention phase; 80% of the data points fell within the 20% stability envelope of the median point. Since 80% of the data points were stable, the baseline conditions could be reinstated to determine investigate possible presence of functional relationship. Student B, using the student questionnaire, rated the intervention used the 5-point Likert scale a 4.75. This student said they enjoyed the yoga GoNoodle brain breaks the most.

Student C

The collected data for Student C’s on-task behavior across baseline and intervention conditions are presented in Figure 3. During baseline condition, there was a slight decelerating trend in Student C’s on-task behavior. The calculated variability of baseline data indicated that
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50% of points fell within the stability envelope (20% of median). Since baseline data were stable across four collection sessions, the intervention of brain breaks was implemented. Implementation of the brain breaks showed a significant and abrupt level change between baseline and intervention conditions. The relative level change seen across these conditions was 45.75% in the desired direction. The trend of data in the intervention phase was accelerating. The PND between baseline and intervention was 100%. Little variability of data was evident in the first intervention phase: 80% of the data points fell within the 20% stability envelope of the median point. Since 80% of the data points were stable, the baseline conditions could be reinstated as an attempt to replicate results. Student C rated the intervention using the 5-point Likert scale, on the student questionnaire, a 4.75 and they stated, “I think GoNoodle was fun because you get to exercise so you can work better.”

Figure 1. Student A’s on-task behavior across baseline and intervention conditions.
Figure 2. Student B’s on-task behavior across baseline and intervention conditions.

Figure 3. Student C’s on-task behavior across baseline and intervention conditions.
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<table>
<thead>
<tr>
<th></th>
<th>Relative Level Change</th>
<th>Absolute Level Change</th>
<th>Stability Envelope</th>
<th>Percentage of Non-Overlapping Data (PND) (A-B-A-B)</th>
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<tr>
<td></td>
<td>AB</td>
<td>BA</td>
<td>AB</td>
<td>BA</td>
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<tr>
<td>Student A</td>
<td>38.9%</td>
<td>33.75%</td>
<td>30%</td>
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<td>Student B</td>
<td>37.5%</td>
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<td>Student C</td>
<td>45.75%</td>
<td>33.75%</td>
<td>60%</td>
<td>40%</td>
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Discussion

The purpose of this study was to determine the effects of brain breaks, as implemented in a classroom setting, on the on-task behavior of students in an attempt to validate a more time-and cost-effective solution to students’ lack of focus in the classroom. Prior to this study, the participants had a difficult time staying on-task in the afternoon. The results of the study indicate a functional relationship between the independent variable of brain breaks and the dependent variable of on-task behavior. There was an immediate and abrupt impact on each participant’s behavior both times that the intervention was introduced. This effect on each participant shows both intra-subject replication, the experimental effect was repeated with the same participant, and inter-subject replication, the experimental effect was repeated for different participants. This shows strong internal validity in the study. For all students, the introduction of the intervention,
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brain breaks, had a significant and abrupt change on the data in the intervention phase. All
students’ on-task behavior improved from the baseline phase to the intervention phase by 15 data
points or more in the desired direction. This pattern, found across conditions for each student,
shows the effect that brain breaks had on each participant’s on-task behavior, and demonstrates a
functional relationship between use of brain breaks and non-use of brain breaks.

Relevance of the Findings

The results of this study indicate that brain breaks can be effective for increasing on-task
behavior for students in third-grade. The findings from this study contribute to future studies on
exercise and on-task behavior because it shows that brain breaks are a worthwhile use of time in
the classroom and may support the learning of students who are diagnosed with ADHD. These
findings are relevant to the participant’s future teachers, the current classroom teacher and all
other elementary school teachers. The intervention was successful to increase on-task behavior
for the participants. This means that, whenever this particular intervention is being used, this
group of students will most likely exhibit on-task behavior more often than they did before the
start of this study. The increase of on-task behavior can lead to greater scores in academic
achievement and less behavior issues. The findings are beneficial to the teacher and special
education teachers because they provide a quick and simple break to redirect inappropriate
behaviors and keep students on-task. This group of low on-task students increased their on-task
behavior significantly, which is beneficial to classroom management and academic performance.
This brain break can lead to fewer interruptions and behavior issues during class lessons because
the students are able to let out energy and refocus after the break. Finally, these findings are
relevant to elementary school teachers because this brain break is very simple and cost-effective
making it easy to adapt into the average class day.
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The results of this study support the previous findings from Jarrett et al. (1998) that have shown that children tend to become less attentive when sedentary for long periods of time and that children are more on-task when they have a break for physical activity compared to when they have no physical activity at all. This study also supports previous studies that have used teacher-directed physical activity breaks to increase physical activity, on-task behavior and academic skills in the classroom (Erwin et al., 2011; Hoza et al., 2014; Mahar et al., 2006). The effectiveness of the brain break intervention demonstrated in this study creates an opportunity for future researchers to determine how various types of brain breaks or physical activity breaks can increase on-task behavior in the elementary school classroom.

Limitations

One limitation in this study is the small sample size. Since this is a single subject research design, only three participants were observed throughout the course of this study. The three students were of varied ability levels therefore this study has stronger external validity and generalizability. All students in the classroom participated in the brain break activity and the teacher reported better behavior in the classroom as a whole. A second limitation to the study that could have affected the results is the short amount of time and the limited number of data points collected due to the researchers time frame and the many cancelled school days. In order to negate this limitation, future studies should implement the intervention for a longer period of time and assess findings.

Implications

This study provides several implications for teachers and researchers. This study is relevant to all educators; this quick method of getting students up and moving is growing in popularity and is an easy way to improve student behavior. Additional research is needed to
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evaluate the effectiveness of classroom-based physical activity breaks on academic performance. Testing the impact on academics may create a compelling reason for schools to implement more physical activity during the school day. The results from this study demonstrated that brain breaks were effective in improving behavior for three third-graders; implying that GoNoodle and other brain breaks may be beneficial for teachers to use in their classrooms.
References


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# Procedural Fidelity Checklist

<table>
<thead>
<tr>
<th>Session</th>
<th>Date</th>
<th>Teacher Signal *GoNoodle</th>
<th>Students stand behind desks</th>
<th>Technology Works</th>
<th>Back to Seat</th>
<th>Collect data</th>
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* *GoNoodle is a registered trademark of ScanTron, Inc.*
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Appendix B
Student Social Validity Questionnaire

Brain Break Acceptability Questionnaire
For each statement, circle one number that best describes how you feel about GoNoodle brain breaks.

1. Do the GoNoodle Activities help you stay focused in the classroom?

   Strongly Disagree                           Strongly Agree
   1       2       3       4       5

2. Do you enjoy having a GoNoodle break during the class day?

   Strongly Disagree                           Strongly Agree
   1       2       3       4       5

3. Would you want to have GoNoodle in the classroom again?

   Strongly Disagree                           Strongly Agree
   1       2       3       4       5

4. Do you think other students would like GoNoodle?

   Strongly Disagree                           Strongly Agree
   1       2       3       4       5