International Journal of Teaching and Learning in Higher Education
http://www.isetl.org/ijtlhe/
2022, Volume 33, Number 2, 110-118
ISSN 1812-9129

Let's Take a Break: The Impact of Physical Activity on Academic Motivation

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Physical activity is linked to increased motivation and academic performance, yet the majority of research has focused on elementary and high school children. The current investigation evaluated this dynamic in college students (N = 209) by introducing a physical activity break at the mid-point of a videoed lecture and were divided into four conditions: control (no exercise), yoga, mild exercise, and moderate exercise. Students completed a motivation survey measure before the break and at the end of the lecture, followed by a quiz. Results showed that an intervention of moderate exercise and yoga were useful in increasing motivation and energy in college students. Interestingly, however, physical activity did not result in an increased retention of material. Future research is needed in a functioning classroom to evaluate the impact of exercise on academic motivation.

The academic shift to exclude physical education and recess from public schools has led to a new onslaught of research on the benefits of physical activity (Howie & Pate, 2012). This shift is concerning, as historical research directly links physical activity to notable academic improvements in the K-12 setting (Archer & Garcia, 2014; Castelli, Hillman, Buck, & Erwin, 2007; Trudeau & Shephard, 2008). Interestingly, the college student population has been largely ignored in this quest, with the focus of contemporary research on primary and secondary school levels. In comparison to primary and secondary students, college students may be at risk for decreased physical activity because much of their time is spent attending longer lectures, sitting in front of the computer, or watching television, while at the same time decreasing time spent in extracurricular sports and activities due to the need to spend time studying or otherwise preparing for class (Calestine, et al., 2017). Furthermore, the psychological effects of a sedentary lifestyle can include mental fatigue and boredom during classes (Mann & Robinson, 2009), which could result in a decline in motivation. To combat these issues, some authors have called for breaks during courses (Wambuguh, 2008). The current study introduced a physical activity intervention during a simulated lecture to determine the outcome of such an intervention. Specifically, the researchers presented a video of a lecture that was shown in a classroom setting to all participants. At the midpoint of that lecture, participants were led on an exercise routine that varied by condition. By combining a break with a short bout of exercise, this study expands the current literature regarding an improvement in the undergraduate academic experience, specifically with motivation and energy.

Physical and Psychological Benefits of Exercise

Physical benefits. In non-student populations, exercise has been shown to be beneficial in multiple ways. Puetz, et al. (2006) conducted a meta-analysis with studies exploring the effects of exercise on a variety of medical populations, such as patients with cancer, chronic fatigue, and depression. They discovered that implementation of short, repeated exercises (i.e., cardiorespiratory, strength, and stretching) led to reports of increased energy and reduced fatigue. In addition to increasing energy, both correlational and experimental studies have demonstrated that physical activity may result in increased academic success. Specifically, correlational assessments with elementary and high school students show a positive relationship between GPA and the average number of minutes of physical activity per week (Donnelly & Lambourne, 2011; Edwards, et al. 2011; Howie & Pate, 2012; Kwak et al., 2009; Rasberry et al., 2011; So, 2012; Trudeau & Shepard, 2008), especially seen in girls (Kwak et al., 2009) and teens (Trudeau & Shepard, 2008). Vazou, et al. (2012) examined the use of ten-minute exercise interventions during 45-minute lectures for elementary school children and measured perceptions of the lectures using the Intrinsic Motivation Inventory. Children perceived lectures incorporating the interventions as more interesting and enjoyable, and they put more effort into them compared to lectures without physical activity.

Another meta-analysis appraised the results of 43 different studies assessing the effects of physical education (PE) courses, recess, and after school sports on classroom behaviors, math, reading, writing, and overall GPA (Rasberry et al., 2011). In their study, Raspberry et al. noted that over half the studies found positive associations between physical activity and academic performance. Esteban-Cornejo, et al. (2015) discovered that physical activity, particularly cardiorespiratory fitness, was linked with increased academic achievement. Other research determined that additional time spent in PE courses had an upward influence on elementary aged students' academic scores (Dwyer, et al., 1996; Ericsson, 2008; Lynch, 2015). Increased time spent, along with a higher intensity of physical activity, at recess led to a marked improvement in teacher reports of student behavior in the classroom (Maeda & Randall, 2003; Mahar et al., 2006; Norlander, et al. 2005). In subsequent research, Bass, et al. (2013) demonstrated that academic achievement had the strongest relationship to aerobic capacity measured during PE courses: physically fit individuals were two to four times more likely to pass both reading and math standardized tests compared to student who were less aerobically capable. Muscular strength was also related to elevated academic performance but with a weaker relationship than physical abilities. Thus, the academic benefit of short bouts of exercise is documented for young students. Despite the described benefits of physical activity in lower grades, implementation at the high school and college level mean excluding activities such as recess and physical education courses.

Physical activities are integrated at higher levels of education through extracurricular sports and athletics. Light (2001) investigated students enrolled at Harvard who were also participating in varsity athletics and found that they reported a greater satisfaction with the collegiate experience but held lower GPAs than their non-athletic peers. This glimpse at student athletes may imply greater psychological wellbeing, but the correlational nature of the study was unable to determine issues beyond physical activity that may have influenced the decrease in student grades. Conversely, two experimental studies utilizing student athletes found cognitive benefits employing a physical activity manipulation. Kashihara and Nakahara (2005) discovered participants illustrated decreased reaction times on a three-choice task during and immediately after a short bout of exercise maintained at the anaerobic and lactate thresholds. The researchers believed that this indicated an increase in executive cognitive functioning. Support of this assumption resides in a second study incorporating an Eriksen flanker task that targets both attention and executive functioning (Hillman, et al., 2003). Participants were asked to complete the task either with or without exercising beforehand. After cardiovascular activity, participants showed greater cognitive functioning. A third more recent study extended the subject pool outside the university and found similar reaction time results with participants ranging in ages from 20 to 80 years old (Hogan, et al., 2013); they, therefore, found that the positive effects are consistent across all age groups. Regardless of these findings, only a limited amount of research has focused on the undergraduate population specifically in the classroom setting.

Psychological benefits. In conjunction with the aforementioned findings, research has also found psychological improvements through exercise. Caldwell, et al. (2009) found that when college-aged individuals took part in a Pilates class for either 75 minutes twice a week or 50 minutes three times a week, their self-efficacy increased, along with their positive mood. Another study looked at Baduanjin, a traditional Chinese exercise, as a possible way to improve physical and mental health (Li et al., 2015). They discovered that in addition to some physical improvements, there was also a positive impact on attention.

Lecture breaks. Lack of attention is a common obstacle for any method used to improve grades. Bunce, et al., (2010) stated that college students may have trouble focusing during a lecture and their attention waxes and wanes throughout the class period. Students often experience several attentional lapses of less than a minute, and the researchers attributed these to a loss of motivation and lack of interest in the material being presented. When asked, 95% of student respondents characterized *some to most* of their time spent in lecture as boring (Mann & Robinson, 2009). These statistics are disconcerting since describing a course as boring is a common excuse for undergraduates to “ditch” that particular course. Surprisingly, pedagogical strategies currently employed by instructors, such as lecture PowerPoint presentations with and without handouts, were rated as moderately boring depending on the course material. As a prescription against boredom, Wambuguh (2008) suggested long lectures be broken up into shorter segments, especially in evening courses which tend to be significantly longer than daytime courses.

Various types of lecture breaks, other than for exercise, have been previously examined. Ruhl, et al., (1990) evaluated a “pause” procedure by adding two-minute pauses in a 22-24-minute lecture. During the break, students were instructed to pair up with another individual and review the content. This design produced enhanced short-term recall and performance on multiple-choice tests for both learning disabled and nondisabled college students. In other studies, engaging breaks have also been successfully implemented during lectures. First-year dental students completed activities to apply newly learned knowledge (e.g., completing problems concerning the content; Miller, et al., 2013), which lead to improvement in students’ perception of the course, ability to pay attention, confidence with the material, and exam scores compared to participants in a traditional lecture without a break.

These studies provide evidence that lecture breaks involving mental activities are beneficial, but little research has been conducted utilizing physical activities within the lecture, despite its promising psychological benefits. The current study sought to rectify this gap and determine if short bouts of aerobic activity during lectures would improve cognition, motivation, and attention, and thus increase academic performance in college students.

Present Study

Considering the results of past studies, it was hypothesized that the combination of a lecture break *and* physical activity would increase attention and motivation during a lengthy lecture. By interrupting learning periods with eleven-minute exercise interventions to boost engagement and performance, we expected to find an increase in participants' motivation to attend to the lecture material in all intervention conditions. In addition, it was predicted that students in the intervention groups would report higher levels of energy than those in the control condition. Finally, it was expected that there would be an increase in memory exhibited by a greater retention of the content in all intervention conditions.

Material and Methods

Participants

Participants were recruited from an Introduction to Psychology course at a four-year, midwestern university. Institutional Review Board approval and informed consent was obtained prior to data collection. Upon consent, 209 students participated for research credit. Students logged into an online experiment management system using an existing username and password. Participants consisted primarily of women (63.2%), were students who identified as White (86.6%), and were classified as first-time freshmen (61.2%). All individuals (100%) reported being enrolled as full-time students, and the mean reported age of participants was 19.0 years (standard deviation [SD] = 1.7 years).

Measures

A scale created by the researchers, the Assessment of Perceived Motivation (APM), was used to evaluate the participants' situational motivation as it directly related to the lecture used (see Appendix). The statements consisted of five Likert type items ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Participants were asked their level of agreement with statements regarding emotional states and perceptions of doing well on the quiz over the lecture material. This questionnaire was completed by all participants before and after the manipulation.

Participants were screened for potential health issues using the Physical Activity Readiness Questionnaire (Par-Q; Warburton, et al., 2011). At the completion of the tasks, a participant demographic form was completed.

Procedure

Participants were tested in groups of up to 20 students in a classroom setting on campus. Upon entering the room, they were told the purpose of the study was to determine influences on academic performance and motivation during a classroom lecture presentation; the description was intentional to disclose the general nature of the project prior to (manipulation issues potentially caused by this action are addressed in the limitations section). Participants were also informed that a quiz over the presented material would be given at the end of the lecture. The lecture consisted of a video covering various landscaping and gardening techniques. This topic was chosen specifically because the information it provided would not duplicate any course offerings within the psychology department. Participants were expected to be unfamiliar with the information presented to eliminate any confounds created by previous knowledge. The lecture was presented to all groups in entirety; additionally, the video version was consistent for all groups.

Participants were randomly assigned to one of four groups: control, yoga, mild exercise, and moderate exercise. All participants watched the same 30-minute recorded lecture on landscaping, and each group received a break during the mid-point of the lecture. The control condition participants were told to stay in their seats for the entire 11-minute break. This method was chosen to control participants' physical activity, rather than their cognitive activity, to facilitate the determination of the impact of exercise while avoiding the use of arduous or repetitive (i.e., potentially boring) cognitive tasks that could have interfered with the break. Individuals in the yoga condition were led through a five-minute yoga video, given a one-minute break, and then led through the yoga video again. Those in the mild exercise condition were led through a five-minute stretching video, given a one-minute break, and then repeated the video. Participants in the moderate exercise condition were led through a five-minute exercise video, given a one-minute break, and led through the exercises again to achieve an increased heart rate above baseline before returning to their seats and resuming the lecture.

At the beginning of the break, participants completed the APM. After the activity (or lack thereof), every participant then completed the APM again before resuming the lecture. Upon conclusion of the video presentation, each participant completed a 20-item quiz over the material, followed by the demographic questionnaire.

Results

Data analysis

Data screening. All data were analyzed using IBM's Statistical Package for the Social Sciences (SPSS) software version 25. Although the total number of missing values constituted less than 2% of the total data, these values were analyzed using Little's (1988)

Table 1
Means, Standard Deviations, Minimums, and Maximums for all Dependent Variables by Condition

	Condition							
	Control		Mild Exercise		Moderate Exercise		Yoga	
Variables	Mean (SD)	Min, Max	Mean (SD)	Min, Max	Mean (SD)	Min, Max	Mean (SD)	Min, Max
Change in Motivation	.3 (.9)	-2, 3	.4 (1.3)	-3, 4	1.0 (1.3)	-1, 4	1.5 (1.9)	-3, 6
Change in Energy Level	.5 (1.3)	-3, 4	1.0 (1.5)	-1, 5	2.1 (1.3)	0, 4	2.3 (1.9)	-1, 6
Quiz Score	7.0 (2.6)	2, 16	6.3 (2.2)	2, 11	6.5 (1.8)	3, 10	7.0 (2.8)	2, 17

Note. Change scores were calculated by subtracting pre-activity measures from post-activity measures across subjects. SD = Standard Deviation, Min = Minimum, Max = Maximum.

missing at random (MCAR) test. This test was found to be nonsignificant ($\chi^2 = 8.31$, $p = .959$), supporting the use of listwise case deletion for all hypothesis test analyses. Assessment of univariate outliers was performed using a 1.5 interquartile range threshold, whereas the assessment of multivariate outliers was determined by computing the Mahalanobis distance for each case on the continuous variables. Results of the outlier analyses revealed two cases that were potential univariate outliers and one case that was a potential multivariate outlier, but given the low number of cases identified in this analysis, all cases were retained. One case was removed due to missing data from an entire scale, and thus the final number of available cases for data analysis following screening was 208.

Following the initial screening, change scores were created by subtracting the level of self-reported motivation or energy post-activity from the self-reported pre-activity level (i.e., post-score – pre-score), such that positive scores indicated an increase in the variable of interest and negative scores indicated a decrease. Descriptive statistics analyses of the change scores and quiz scores revealed that change in motivation scores and quiz scores both demonstrated unacceptable levels of positive skew (above +1); however, screening by category revealed that both of these variables demonstrated non-normality via skew in only the control condition. Additional analyses revealed heterogeneity of variance across the levels of the independent variable (i.e., type of activity). The data were unable to be transformed to demonstrate both normality and homogeneity of variance, and thus the untransformed values were used in the hypothesis testing. Descriptive statistics for these variables by condition are listed in Table 1.

Hypothesis testing. Hypothesis testing was accomplished by separately examining the change score in self-reported measures of motivation and energy, as well as the lecture quiz total score, for each condition. Because of the violated assumptions of normality and homogeneity of variance, all hypotheses were evaluated by using nonparametric tests. Due to time constraints outside of the researchers' control, participants were tested in various conditions at different times throughout the data collection window; this resulted in differing sample sizes for each of the condition groups.

Self-reported change in motivation. For the self-reported motivation analysis, a Kruskal-Wallis test was performed with condition as the between subjects variable (type of activity: control/no exercise [n = 85], mild exercise [n = 43], moderate exercise [n = 28], yoga [n = 50]) and change in self-reported motivation as the within-subjects variable. The analysis revealed a significant effect of condition on change in motivation, $H(3) = 22.4$, $p < .001$, $\eta_p^2 = .11$ (all effect size calculations were conducted according to recommendations by Green & Salkind, 2008). Pairwise comparisons conducted using Mann-Whitney tests with Bonferroni-style corrections ($\alpha = .008$) revealed that, compared to the control condition (Mean Change [$M\Delta$] = .29, Standard Error [SE] = .10), average self-reported motivation was higher in the moderate exercise, $M\Delta = 1.03$, SE = .24, $U = 810.0$, $p = .002$, and yoga conditions, $M\Delta = 1.46$, SE = .27, $U = 1241.5$, $p < .001$. Similarly, motivation was higher in the yoga condition than in the mild exercise condition, $M\Delta = .42$, SE = .20, $U = 714.0$, $p = .002$ (all other comparison p's > .06).

In sum, these analyses supported our hypothesis that participating in moderate exercise or yoga would result in increases in self-reported motivation levels but did not support our hypothesis that participants of mild exercise would also reap these benefits.

Self-reported change in energy level. As with the previous analysis, a Kruskal-Wallis test was again performed with condition as the between subjects variable (type of activity: control/no exercise [n = 85], mild exercise [n = 43], moderate exercise [n = 28], yoga [n = 50]) and change in self-reported energy level as the within-subjects variable. As before, there was a significant effect of condition on change in energy level, $H(3) = 41.0$, $p < .001$, $\eta_p^2 = .20$. Furthermore, the pattern of significance found in the pairwise comparisons of energy level mimicked the findings related to motivation. Specifically, Mann-Whitney tests with corrected α levels revealed a significant difference in energy levels between the control group, $M\Delta = .53$, SE = .14, and both the moderate exercise, $M\Delta = 2.07$, SE = .25, $U = 484.0$, $p < .001$, and yoga conditions, $M\Delta = 2.26$, SE = .27, $U = 991.5$, $p < .001$. Similarly, the difference between self-reported energy levels in the mild exercise condition ($M\Delta = 1.02$, SE = .23) also differed significantly from both the moderate exercise, $U = 349.5$, $p = .001$, and yoga conditions, $U = 661.5$, $p < .001$ (all other comparison p's > .10). Thus, our analyses supported the hypothesized increase in self-reported energy levels following a physical activity for both the moderate exercise and yoga groups, but again failed to support the hypothesized increase in this attribute for the mild exercise group.

Learning quiz score. To determine if there were differences in the learning quiz score between conditions (i.e., type of activity: control/no exercise [n = 86], mild exercise [n = 43], moderate exercise [n = 29], yoga [n = 50]), a Kruskal-Wallis test was performed. This analysis revealed no significant difference in quiz score between groups, $H(3) = 1.1$, $p = .781$, and thus no subsequent paired comparisons were performed. This finding indicates that, contrary to our hypothesis, quiz score is unaffected by the type of physical activity undertaken.

In sum, our analyses revealed a significant difference in change in self-reported motivation and change in self-reported energy level based upon the type of activity that students participated in. Motivation was found to be significantly higher in the moderate exercise condition than in the control condition, and higher in the yoga condition compared to both the control and mild exercise conditions. Individuals in the moderate exercise and the yoga conditions also reported greater increases in energy levels than individuals in both the control and mild exercise conditions. These results are shown in Figure 1. In contrast to the significant findings related to motivation and energy level, there were no differences in mean learning quiz scores across groups.

Discussion

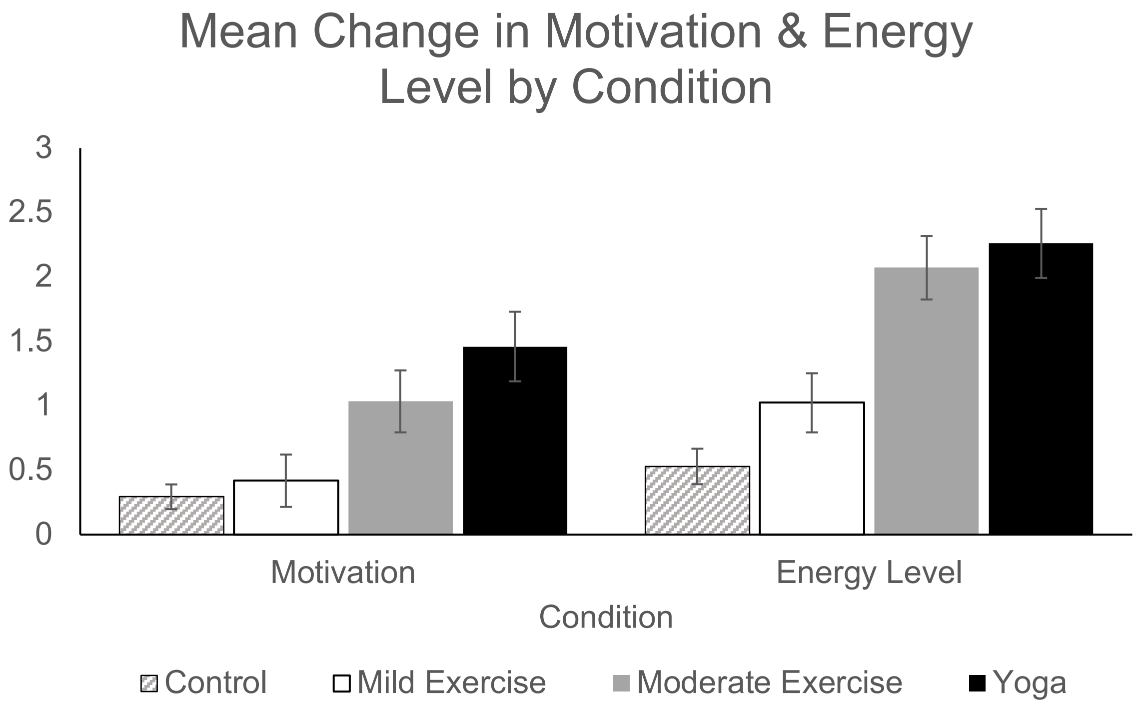
The purpose of this study was to explore the implications of providing an exercise break at the midpoint of a long lecture. Previous research has shown that breaking during a lecture is a possible solution to boredom and decreases in motivation (Wambuguh, 2008). Particularly, we proposed applying exercise during breaks as a result of several findings that physical activity is positively correlated with GPA (Donnelly & Lambourne, 2011; Edwards et al., 2011; Howie & Pate, 2012; Kwak et al., 2009; Rasberry et al., 2011; So, 2012; Trudeau & Shepard, 2008). In addition to GPA, exercise also increased motivation (Vazou et al., 2012) and energy (Puetz et al., 2006) in numerous domains.

The present study revealed useful information about the effectiveness of certain teaching practices for engaging and motivating students. Partially supporting our first hypothesis, motivation was enhanced by encouraging students to participate in physical activity, specifically yoga or moderate exercise, during break times. Increasing professor awareness regarding the need to divide class periods with short exercise breaks could greatly benefit student engagement. This is especially true when physical activity breaks are applied to long classes where students sit for an extended period of time. The researchers believe specific exercise during the break is the missing piece that can lead to a significant impact on student engagement in a course.

Our second hypothesis was also partially supported with an increase in self-reported energy levels after a break for moderate exercise or yoga. This is consistent with previous findings that exercise increases reported energy levels (Puetz et al., 2006). However, it is interesting that the mild exercise condition did not increase energy or motivation. It is possible that the mild exercise condition was too mild and, essentially, no different from the control condition.

We anticipated that improved functioning would translate to better retention of course material. Contrary to this hypothesis, the experimental participants did not score higher on the quiz than the control subjects. This was discouraging as past research had shown improvements in cognitive functioning both during and after participating in exercise (Hillman, et al., 2008; Hillman et al., 2003; Kashihara & Nakahara, 2005). Two possibilities should be considered for these findings. First, the presentation utilized in this study was a technical lecture in the area of landscaping. It was chosen specifically because participants would be unlikely to have prior knowledge about the subject since all of the participants were recruited from within the psychology department. Yet, it is doubtful they found the lecture to be interesting or of informational value. This could have reduced students' intention to encode the material, and thus reduced their overall retention rates. Considering that the average score on the quiz (collapsed across conditions) was a 6.8 out of 20 (or 34%), it seems likely that this was the case. Thus, our use of this particular type of presentation seems to have resulted in a partial floor effect. Secondly, and likely contributing to the first issue, the novelty of the lecture topic created difficulty in designing a quiz that was appropriately challenging. The technical nature of the material, combined with a lack of familiarity with the subject matter, could have made the quiz too arduous for the participants overall.

Figure 1
Mean change in motivation & energy level by condition.



Note. Error bars represent standard errors.

Limitations

Despite the encouraging findings of this study, a few limitations exist. The first is related to the demographics of our sample. Universities are becoming more and more diverse from age to ethnic background. The majority of participants were between the ages of 18 to 22, with the mean reported age being 19. Similarly, students identified primarily as White (86.6%), and thus our results may not generalize to students who identify differently. Thus, it would be interesting to determine if a sample that was more representative of the entire United States would elicit different results. Another issue of note in the present study is that the nature of the experiment was not concealed from the participants. That is, during the informed consent procedure and the health screening procedure participants would have been aware of the (potential) use of physical activity in the experiment. Thus, it is possible that demand characteristics may have biased the motivation scores (i.e., participants indicated higher motivation due to knowledge of the experimental manipulation) while leaving memory for the presentation material (an aspect less directly under participant control) less influenced. This should be considered in future research, wherein deception might be used to avoid the impact of such issues. Lastly, as mentioned previously, the nature of the content and the test over the material may also have limited our findings by not tapping into or eliciting students' interest and, by extension, their motivation.

Future Research

While every effort was made to replicate an academic environment, true success of the physical activity intervention cannot be claimed until it is tested in a functioning classroom. Future studies should extend this line of research to an actual course where exercise breaks are implemented for an experimental group and compared to a control group. The college standard with several sections of the same material offered at various times of the day and week supply the perfect ready-made design for such an experiment. Additionally, types of instruction should also be evaluated. In sum, an examination within the classroom affords the possibility of long-term evaluation into the exercise and academic motivation dynamic; it would allow the researchers to revisit issues raised by the lack of differences in quiz scores. If students choose to enroll in a course, the material will have more personal value than any information they are presented and tested on in a lab setting.

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Appendix

Assessment of Perceived Motivation (1)

Use the scale below to rate your level of agreement with each of the following statements in regard to the lecture.

	Strongly Disagree			Neutral			Strongly Agree
1. I am motivated to pay attention to this lecture.	1	2	3	4	5	6	7
2. I feel like I am going to do well on the test over this material.	1	2	3	4	5	6	7
3. I feel refreshed and energized to listen to the remaining lecture.	1	2	3	4	5	6	7

3a. If you disagree with question 3 what do you think can be changed or implemented to enhance your energy levels? ____

4. I feel like it is important to do well on the test over this material.	1	2	3	4	5	6	7
5. I feel like a break will be beneficial to help me focus on the remainder of the lecture.	1	2	3	4	5	6	7

Assessment of Perceived Motivation (2)

Use the scale below to rate your level of agreement with each of the following statements in regard to the lecture.

	Strongly Disagree			Neutral			Strongly Agree
1. I am motivated to pay attention to this lecture.	1	2	3	4	5	6	7
2. I feel like I am going to do well on the test over this material.	1	2	3	4	5	6	7
3. I feel refreshed and energized to listen to the lecture.	1	2	3	4	5	6	7

3a. If you disagree with question 3, what do you think can be changed or implemented to enhance your energy levels? ____

4. I feel like it is important to do well on the test over this material.	1	2	3	4	5	6	7
5. I feel like a break was beneficial to help me focus on the lecture.	1	2	3	4	5	6	7