College Students' Survival Guide: The Effects of Caffeine and Exercise on Working Memory

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Abstract

Considering the course load and daily demands of university students in this generation, it is necessary to investigate the effects of their lifestyle on their cognitive abilities. This study's purpose is to examine how different types of exercise and amount of caffeine consumed impact working memory in college students. It is hypothesized that aerobic exercise and moderate amounts of caffeine will demonstrate the greatest improvements in working memory. The participants will be recruited from a participant pool from Tulane University. The desired sample is at least 50 participants, 50% male and 50% female who exercise between once and twice per week.

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All-nighters, large amounts of caffeine, and a lack of exercise characterize the typical university student today. This lifestyle has potential to impact their cognitive functions, including working memory. Research has shown that aerobic exercise has positive effects on working memory, while resistance exercise has no significant effects (Pontifex, Hillman, Fernhall, Thompson & Valentini, 2009). Meditation has also been shown to improve working memory (Vugt & Jha, 2011). However, past research has not examined the hierarchical beneficence of these different forms of exercise. In addition, caffeine has been linked with increased working memory in other populations, but has not yet been studied in young adults (Klaassen et al., 2013). The research on the effect of caffeine on working memory in young adults has yielded varied and unclear results (Smith, Clark & Gallagher, 1999 and Childs & deWit, 2006). Thus, this study chose to examine the effects of exercise and caffeine on working memory in university students. In past studies, gender has mediated the relationship between exercise and cognitive function, so gender was used as a matching variable (Etnier et al., 1997). This research could be used to provide support for students, by teaching them which strategies are most beneficial to implement for optimal cognitive functioning. With the knowledge that a certain type of exercise or amount of caffeine is linked to improved working memory, students could implement these tactics in their daily lives to ameliorate not only their educational performance, but also their overall functioning. It is expected that aerobic exercise, meditation, and moderate amounts of coffee will be linked to improvements in working memory. It is also expected that type of exercise will vary across amount of caffeine administered, with highest improvements seen in the aerobic exercise and two cups of coffee condition.

Hypotheses

Hypothesis 1

H_0. Aerobic exercise will have no effect on working memory.

H_1. Aerobic exercise will have a positive effect on working memory.

Hypothesis 2

H_0. Resistance exercise will have an effect on working memory.

H_1. Resistance exercise will have no effect on working memory.

Hypothesis 3

H_0. Meditation exercise will have no effect on working memory.

H_1. Meditation exercise will have a positive effect on working memory.

Hypothesis 4

H_0. Drinking two cups of coffee will have no effect on working memory.

H_1. Drinking two cups of caffeine will have a positive effect on working memory.

Hypothesis 5

H_0. Drinking one cup of coffee will have no effect on working memory.

H_1. Drinking one cup of coffee will have a positive effect on working memory.

Hypothesis 6

H_0. The effect of exercise on working memory will not be mediated by caffeine levels.

H_1. The effect of exercise on working memory will be mediated by caffeine levels.

Method

Participants

The proposed sample is composed of university students ($n \geq 50$) recruited from a participant pool at Tulane University (i.e. SONA). They will be 50% male and 50% female. They will be people who generally exercise one to two times per week. This particular sample is of interest because the study is interested in generalizing the findings to students on university campuses. Two potential confounding variables were controlled for, gender and overall fitness

level. The sample was matched for gender and the range was restricted to those who exercise one to two times per week, as determined by a prescreening survey.

Procedures

The participants will be divided into four groups, 50% male and 50% female in each group. These groups will engage in aerobic exercise, resistance exercise, meditation, or no exercise. The aerobic exercise group will all use the elliptical at the same incline with no resistance for thirty minutes. The resistance exercise group will lift various weights in the legs, arms, and abs regions, optimally tailored to them as determined by a baseline measurement that is detailed below, for thirty minutes. The meditation group will listen to audiotapes by Dr. Kristin Neff, an educational psychologist specializing in the areas of meditation and self-compassion, for thirty minutes. For the participants in the no exercise control condition, the exercise trial will consist of sitting quietly for thirty minutes.

Each group will come in for a baseline measurement before the start of the study. The resistance exercise group will be tested to determine the optimal weight they can lift during the trials. The rest of the groups will be brought in for control purposes, with group participants sitting separately in a waiting room for the duration of the measurement of the resistance exercise group.

Each exercise group will go through four caffeine trials administered over four weeks, held on the same day and same time of each week. Complete counterbalancing will be used in order to minimize sequencing effects. One condition will consist of consuming two cups of regular, medium-roast PJ's coffee. Another condition will consist of consuming one cup of regular, medium-roast PJ's coffee. The placebo control condition will consist of consuming one cup of decaf PJ's coffee. The control condition will consist of consuming no coffee and sitting quietly at a table for ten minutes, around the amount of time it would take to drink a cup of

coffee. The caffeine will be administered before exercise to half of each exercise group and after exercise to the other half. This will be done to ensure that the order in which the caffeine and exercise conditions are completed does not impact the results.

Working memory will be assessed using the Sternberg task, as detailed below. The task will be administered directly before and after caffeine intake, directly before and after exercise trial, and thirty minutes after completion of both conditions for each participant.

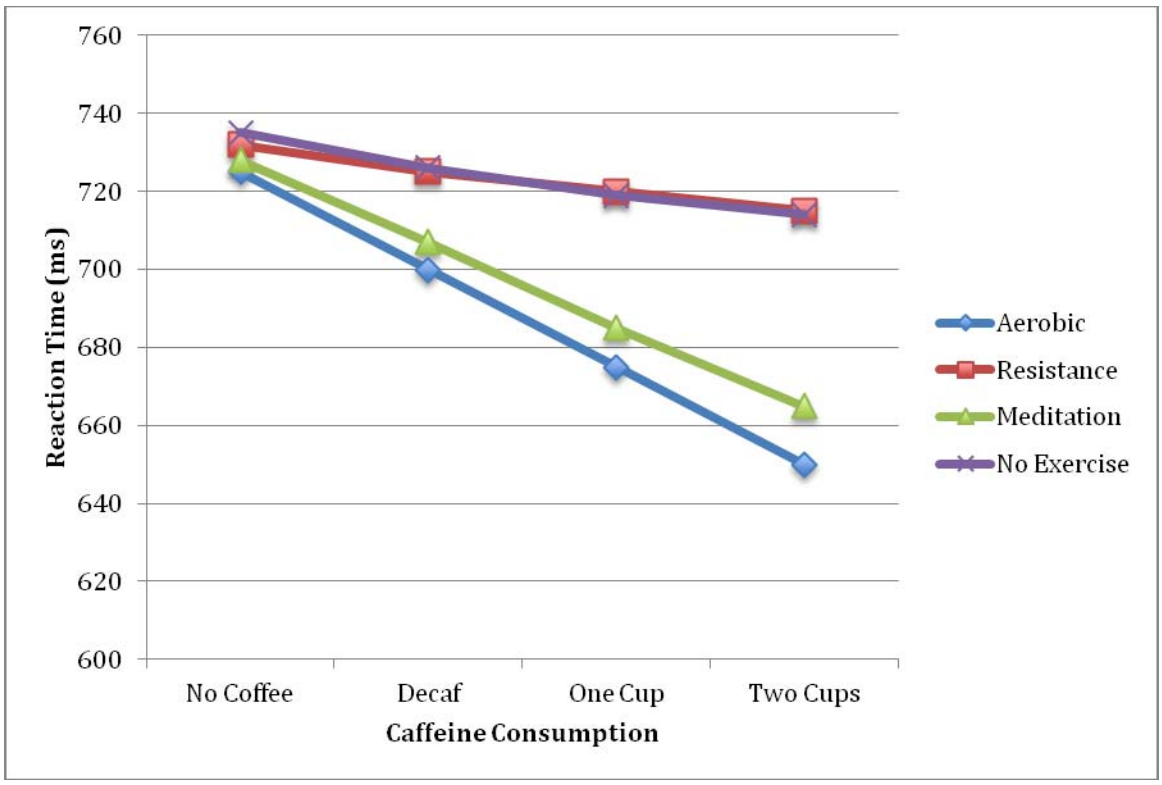
Caffeine

Exercise	2 Cups	1 Cup	Decaf	Control (no coffee)
Aerobic Exercise	AE, 2 Cups	AE, 1 Cup	AE, Decaf	AE, No coffee
Resistance Exercise	RE, 2 Cups	RE, 1 Cup	RE, Decaf	RE, No coffee
Meditation	Med, 2 Cups	Med, 1 Cup	Med, Decaf	Med, No coffee
Control (no exercise)	Control, 2 Cups	Control, 1 Cup	Control, Decaf	Control, No coffee

Measures

Working Memory Task. The Sternberg task will be used to assess working memory, through presentation of five randomized capitalized consonants (in no particular order) on a computer screen. The participant must remember the items during a memory maintenance period of ½ a second. Then, the participant will be presented with one probe letter at a time, whose presence or absence in the previous set will occur with equal probability. The participant will be probed five times. The participants were previously instructed to respond as quickly and accurately to the probe as possible. The subject is given a keypad before the trial and instructed to press ‘YES’ or ‘NO’ according to whether they believe they have previously seen the letter or not. Reaction time (in ms) and response accuracy is recorded. Reaction time indicates rate of memory recall and response accuracy indicates precision of working memory.

Anticipated Results and Discussion



Since this study includes two categorical independent variables and one continuous dependent variable, 2-Way ANOVA will be used to analyze the results. The expected findings are that the condition of aerobic exercise and two cups of coffee will yield the greatest improvement in working memory, as demonstrated by decreased reaction time. In addition, it is expected that both aerobic exercise and two cups of caffeine will individually yield the most substantial improvements in working memory. Main effects of aerobic exercise and meditation on working memory are expected, while it is expected that resistance exercise will not significantly impact working memory. Main effects of one cup and two cups of coffee on working memory are expected, while it is expected that the decaf coffee level will yield a slight improvement in working memory, due to the placebo effect.

Assuming the proposed results hold true, this study will provide evidence that aerobic exercise and moderate amounts of coffee drinking aid in improving working memory. Thus, university students can be advised to implement these strategies in their daily lives in order to

improve their cognitive functioning. If the proposed results are not true, the implications depend on what the results demonstrate. For example, if moderate caffeine use is linked to decreases in working memory, students can be advised to decrease their caffeine intake.

The potential limitations of our study include concerns surrounding measurement validity. All participants were instructed to exercise for thirty minutes, regardless of their optimal exercise level. This could be determined through finding blood oxygen level (VO_2Max) and heart rate during baseline measurement and optimizing trial length for each individual participant. However, due to financial limitations, this was not possible. In addition, caffeine intake was measured by cup and not by milligram, which would have been ideal.

This research has potential benefits for many university students across the United States. If awareness is made of the potential benefits of small lifestyle changes, these adjustments could be made with great advantages.

References

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