4-24-2023

Caffieine's Effect on Reaction Time

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Honors Capstone Formatting Guide

by

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An Honors Capstone

submitted in partial fulfillment of the requirements

for the Honors Diploma

to

The Honors College

of

The University of Alabama in Huntsville

April 21st, 2023

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The Effect of Caffeine on Reaction Time in College-Aged Adults

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April 7, 2023

Abstract

Caffeine is a supplement used daily by the majority of the American population, especially college-aged individuals. When used during studying, students perceive caffeine consumption can improve cognitive ability, primarily alertness, or reaction time. **Purpose:** To determine the impact of caffeine on reaction time in college-aged individuals, researchers hypothesized that increasing caffeine would positively affect reaction time. **Methods**: A total of twenty-three college-aged individuals (age = 21.74 ± 1.69 years, height = 174.47 ± 10.82cm, body mass = 81.65 ± 26.82kg) participated in a double-blind study. Participants were given either 0 mg, 200 mg, or 400 mg of caffeine in the form of pills, in a random order, to take one hour before the testing sessions. Each session included a reaction time test preprogrammed on a Senaptec Sensory Station and occurred on different days with their randomized caffeine amount. **Results**: There were no significant differences in reaction time based upon the amount of caffeine consumed when data was analyzed using a one-way analysis of variance tests ($F = .628$, $p = .470$, $\eta_p^2 = .021$). **Conclusions**: Regardless of the number of students that consume caffeine regularly, this study's findings show that higher caffeine levels do not impact reaction time. This means that as college-aged individuals consume more caffeine for the study benefits, they are not impacting their reaction time.

Keywords: College-Aged, Caffeine, Reaction Time

Introduction

Around 90% of adults in the United States consume 200 mg of caffeine daily, with the general perception that increased caffeine increases alertness, focus, and energy (Minkove, 2020). The results of a study by Zhang (2020) indicated that this perception is accurate in adults, and caffeine consumption improves overall cognitive function through prefrontal activation increases. Ninety-two percent of college-aged adults specifically admit to consuming caffeine daily; due to a busy schedule and demanding workload (Mahoney, 2019).

Caffeine consumption has many effects and uses, from being a common ingredient in pre-workout, causing sleep loss, and increasing alertness (Rosser, 2009). The primary use for caffeine consumption is “to feel awake,” with 79% of habitual college users consuming caffeine for that reason (Mahoney, 2019). Awareness is measured by one's ability to respond to their environment and react accordingly, also deemed reaction time according to a study by Posner (2008).

Another main reason college-aged individuals consume higher levels of caffeine is musculoskeletal benefits, with 27% using it for increased physical advantages (Mahoney, 2019). Caffeine can boost muscular reactions in an exercise environment by strengthening muscle contractions (Rosser, 2009). According to a study by Guest (2021), this is accomplished due to caffeine binding to receptor sites and blocking potential chemicals that would lessen physical performance. The most prominent adverse reaction to caffeine is its primary focus, increasing awareness, but when taken in the afternoon, it harms sleep quality (Sleep and Caffeine, 2018). The results of a similar study by McLellan (2016), found that caffeine levels between 32-300 mg can offset these adverse reactions and boost reaction time, cognition, and alertness.

Current research has focused more on adult subjects, but as stated before, 92% of college students consume caffeine regularly (Mahoney, 2019). Very few studies have been done on caffeine's effect in a college-aged population, even though this is the primary group consuming elevated levels of caffeine. Thus, the purpose of this study was to investigate how caffeine impacts reaction time in college-aged individuals. It was hypothesized that increased caffeine intake would have an increase in reaction time.

Methodology

Participants

The study included college-aged adults (18-30 years) with no reported barriers to testing, such as a history of epilepsy, caffeine intolerance, or those routinely taking over 250 mg of caffeine daily (Childs, 2006). Participants were all recruited from a university in the southeastern United States. The Institutional Review Board approved this study and all methodology before participant involvement.

Procedures

Participants arrived at the human performance laboratory, where all participants performed testing. They completed a consent form and the Physical Activity Readiness Questionnaire, which included questions such as previous medical history, such as epilepsy due to the potential risk from using the Senaptec Sensory Station. To begin testing, participants had their height and weight measured and recorded, with pockets empty and shoes off. Participants were assigned randomized caffeine pills (0 mg, 200 mg, or 400 mg) to take one hour before sessions; doses were assigned at the previous session.

The 0 mg pill was used for a control group consisting of two dextrose pills. The 200 mg dose included one 200 mg caffeine pill and one 200 mg dextrose pill, equivalent to two cups of coffee. For a 400 mg dose, two 200 mg doses were given, equivalent to 4 cups of coffee. This was a double-blind study, with neither the participants nor the researchers knowing the amount of randomized caffeine amounts; this was accomplished using a neutral third party. This process was repeated three times for each caffeine amount.

Participants waited at least 48 hours between trials to ensure there was no residual caffeine in their system; they were also asked not to consume any caffeine 24 hours before their session to not impact the session results. Participants were instructed to keep to the same general diet, hydration, and exercise routine 24 hours before sessions; those who did not follow these instructions were rescheduled for a later time (Guest, 2021).

Participants that met inclusion criteria and followed pre-testing procedures performed a Go No/Go test on a Senaptec Sensory Station. The test included deciphering between yellow and red targets; participants were instructed to hit the yellow targets as fast as possible and ignore the red targets. After participants were instructed and counted down, they had 60 seconds to hit as many targets as possible within the time limit. At the conclusion of the test, the Senaptec Sensory Station displayed the participant's reaction time, which was recorded.

Statistical Analysis

Data was analyzed using the Statistical Package for the Social Sciences, version 28. A one-way analysis of variance test was done to determine the effect varying levels of caffeine (0 mg, 200 mg, 400 mg) have on reaction time. Alpha level was set at .05 for all tests.

Results

Twenty-three participants completed the research study; their baseline characteristics are provided in Table 1. Reaction time was not significantly based on the amount of caffeine that was consumed ($F = .628$, $p = .470$, $\eta_p^2 = .021$). See Table 2 for performance values at each caffeine interval.

Discussion

This study aimed to determine the impact moderate to high levels of caffeine have on college-aged individuals. Reaction time is equitable to factors such as awareness, alertness, and cognitive processing, which all play a role in cognitive function and the main effect of caffeine consumption (Posner, 2008). To address this topic, the participant sample included healthy, college-aged adults with no reported negative reactions to caffeine and not consuming over 250 mg habitually. It was hypothesized that reaction time would improve as caffeine consumption increased from moderate (200 mg) to high (400). The findings of this study did not support the hypothesis. This study's results contrast with previous research on caffeine consumption improving reaction time (Calvo, 2021; Giles, 2012; Kamimori, 2015; Sainz, 2020; Santos, 2014; Souissi, 2012).

Results of studies by Calvo (2021), Kamimori (2015), Sainz (2020), and Santos (2014) used active adult athletes with increasing amounts of caffeine, ranging from 100-800 mg, to measure reaction time; they found that increasing caffeine improved reaction time. The main difference between these studies and this one, was participants took caffeine relative to body weight, which could cause a higher impact, especially in those with a higher body mass index (BMI). However, results of studies by Bartrim (2020), Gendle (2009), and Schneider (2006) found no significant difference in reaction time following caffeine consumption, which coincides with the findings of this study.

Similar to this study, Bartrim (2020), Gendle (2009), and Schneider (2006) all gave participants a set amount of caffeine to consume prior to testing. To the contrast of other studies, research by Giles (2012) and Souissi (2012) found caffeine has a negative impact on reaction time in adult, habitual users, with an inverse relationship between the two. In the study by Giles (2012), participants were withheld caffeine for 24 hours, resulting in withdrawal of participants, as for Souissi (2012), different software was used to calculate reaction time. Findings relating to caffeine intake varied across studies, ranging from positive to negative effects associated with increasing caffeine consumption. The findings of this study, however, agree with the conclusion that caffeine has no statistical effect on reaction time.

The primary limitation of this study would be the levels of caffeine that participants ingested, levels could have been more like popular energy drinks to further simulate caffeine intake of college students. Participants were also tested acutely; a more significant change could have been observed if participants consumed caffeine over a longer period of time. Another limitation is the BMI of participants in relation to caffeine intake. Because caffeine amounts were set, a larger person would see a smaller effect, whereas a smaller person would see a larger effect at the same caffeine levels.

To remove the potential of caffeine tolerance, future research could be conducted using participants that rarely consume caffeine to understand better the effect caffeine can have. In future studies, a variable can be added utilizing perceived alertness, which participants answer before caffeine consumption to assess restfulness pre-testing. Another possibility is to separate the subject group into sexes to account for differences between male and female college-aged individuals.

In conclusion, it was determined that moderate (200 mg) and high (400 mg) levels of caffeine have no significant effect on college-aged individuals ($p > .05$). College-aged individuals have been shown to consume the most caffeine compared to other populations due to the common perception it works as a study material. The findings of this study support the claim that increased caffeine consumption does not have a positive or negative effect on reaction time.

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Table 1. Baseline Participant Characteristics (*n* = 23)

Variable	*M* ± *SD*
Mean Age (years)	21.74 ± 1.69
Height (cm)	174.47 ± 10.82
Body mass (kg)	81.65 ± 26.82
Sex (female/male)	11/12

Note. Values are mean ± standard deviation.

Table 2. Reaction time values based on caffeine consumption

Variable	0 mg	200 mg	400 mg
Reaction Time	0.64 ± .05	0.65 ± 0.07	0.65 ± 0.08

Note. Values are mean ± standard deviation.