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Bre'al Loree Hillery is a Psychology major with a minor in Business Administration from Bogalusa, LA. After graduating in May 2015, Hillery plans to attend graduate school for industrial organizational psychology. She ultimately hopes to open a non-profit organization for alcohol abuse in her hometown. Hillery's research interests include college students, learning, and memory. Hillery's research began in a Research Methods course and continued in Advanced Research when she began studying effects of caffeine on short-term memory loss.

The Effects of Caffeine on Short Term Memory

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Abstract
Caffeine is one of the most frequently used stimulants in the world. However, little is known about the effects of caffeine in low doses. The aim of this study was to examine the effects of caffeine on short-term memory using decaffeinated tea and 55 mg of caffeinated tea. It was hypothesized that caffeine would enhance performance on memory and math tests in low doses. A positive correlation between GPA and caffeine consumption was also predicted. In this study students consumed either caffeinated or decaffeinated Lipton Brand tea. They were then given a post memory assessment and math test. Results indicated that caffeine had a significant effect on memory, but not math test results. There was a positive correlation between GPA and caffeine consumption.

Key Terms:
- Caffeine
- Short-term Memory
- Performance
- Effects
- GPA

Caffeine is one the most frequently used stimulants in the world. Ninety percent of North American adults consume some form of caffeine on a daily basis, making this substance the most commonly used drug in the world (Majithia, 2007). There are approximately 183 million coffee drinkers and about 173.5 million tea drinkers in the United States (Hruby, 2012). According to an article in the Washington Times, the average American ingests as much as 300 milligrams of caffeine per day (Hruby 2012). The widespread natural occurrence of caffeine in a variety of plants contributes to the long-standing popularity of caffeine-containing products in most beverages (soft drinks, coffee, tea) and medications (Roberts 1984). Although caffeine is widely used, unfortunately there is little known about its effects on short-term memory.

Kerr, Sherwood, and Hindmarch (1991) tested the effects of caffeine on short-term memory by using a high dose (300 mg) and a placebo. The participants were given a short-term memory task that required them to remember or memorize a test digit within a short sequence of 4 digits that were presented for only 1.2 seconds to test reaction time. Caffeine ingestion significantly improved performance on this short-term memory task. Durlach (1998) also tested the effects of caffeine on short-term memory. A low dose (60 mg) was used. A delayed matched sample (DMS) and a paired associates learning task (PAL) was given to the subjects. The DMS is often used for working and recognition of memory, and the PAL is the learning of syllables, digits, or words in pairs. Results showed caffeine increased performance on DMS, but did not affect performance on the PAL.

Other studies looked at the effects of caffeine using verbal and memory tasks. Foreman, Barraclough, Moore, Metha and Madon (1989) conducted research with 32 males and administered 0 mg caffeine, 125 mg caffeine, or 250 mg caffeine using a free call "supraspan" word list. The supraspan test involves verbal measures that include word lists. No significant effect was found using this method. Other work, however, suggests that whereas caffeine may improve overall processing speed on tasks, these improvements cannot be attributed to specific effects on response inhibition or selective visual attention (Kenemans & Verbaten, 1998; Lorist & Snel, 1997; Tieges, Snel, Kok, & Ridderinkhof, 2009).

These findings suggest that caffeine related tasks may or may not affect short-term memory. Low to moderate doses (e.g., 20-200 mg) of caffeine produced positive subjective effects including increased energy, alertness, well-being, sociability, and decreased sleepiness and fatigue (Juliano, 2011). To further expand on the effects of caffeine on short-term memory it was predicted that caffeinated tea will enhance performance. Durlach (1998) used a low dose of caffeine (60 mg), and performance improved. Therefore, in this study a low dose of 55 mg of caffeine was used for the caffeinated tea and 0mg of caffeine (decaffeinated tea) was used as a control or placebo group.

Mitchell and Redman's (1992) subjects were asked to abstain from caffeine and other psychoactive substance use for 24 hours prior to testing. The subjects' caffeine use habits were assessed by a survey and then subjects (based on their reported use of caffeine) were designated as: low caffeine user (less than 120 mg a day), moderate caffeine users (between 120 mg and 300 mg a day), or high users (300 mg or more a day). Subjects were given a mental arithmetic task consisting of 30 problems and then asked to do as many problems as they could in one minute. A verbal test was also administered; participants were given a list of words and later asked to recall which words they remembered seeing. The moderate and low users did significantly better than the high users on the mental arithmetic and verbal reasoning.

There are many gaps in the past literature, but little is known about the effects of caffeine on college students. Most of the studies were given to the general public and not specific groups. The majority of the past studies were conducted with Caucasians. Thus, the current study will focus on African Americans. Many of the studies were done using coffee or caffeine pills instead of tea. The present study involved the consumption of tea.

It was hypothesized that caffeine would enhance performance on the memory assessment and math test. Caffeine, being a stimulant, increases alertness and thus may enhance performance. The decaffeinated group was hypothesized to have little to no change on post-test results. It was also hypothesized that there will be a positive relationship between GPA and caffeine consumption.

Methods

Participants

The participants were undergraduates ages 18-24. Participants were recruited from psychology courses. There were 21 participants for this study: 20 African Americans and 1 Caucasian. The mean age of the participants was (M=20.00, SD=1.095). There were 4 male and 18 female participants. Juniors, freshman, sophomores represented 42% and seniors constituted 19% of the sample respectively. Extra credit were given to participants in selected psychology courses.

Materials

The materials used for this study were Lipton Tea® brand caffeinated (55mg) and decaffeinated tea, 8.5oz foam cups, and water for preparation. The memory assessment test consisting of 15 random words generated at randomwordgenerator.com and a math test also consisting of 15 arithmetic problems (elementary third grade level) generated at supramath.com. A survey was used to collect demographics and also frequency of caffeine consumption. The survey questions were open-ended and closed-ended.

Procedure

Before the study began participants were asked to read and sign an informed consent document. At that time participants could ask any questions or leave the study. The participants were given two sheets of paper: a white sheet of paper and a colored sheet. The white sheet had a unique number at the bottom to track participant's answers, which would later be used to compare performance. The participants were instructed not to turn over the colored sheet of paper until instructed to do so. The colored sheet of paper was the memory assessment containing 15 words. The white sheet of paper was used to record answers. The participants were signaled to turn over the colored sheet of paper and try to remember as many words as they could on the count of three. The participants were then given 20 seconds to memorize words. When time was completed the participants were asked to turn over the colored sheet. Participants were given 20 seconds to write down on the white sheet of paper all the words they had remembered seeing.

After the memory assessment was completed and collected, a math test was given out and participants were asked to follow the same procedures as the memory assessment. Immediately after time was completed for the math test, the participants were given tea containing either 55mg of caffeine (caffeinated) or the decaffeinated tea acting as the placebo. After the tea was distributed, a 15-minute film of the movie *Who the Bleep Did I Marry* was shown. This allowed time for onset of caffeine effects (Spiller, 1998; Kamimori et al., 2002; Maisto, Galizio, & Conners, 1999; Warburton, 1995). While watching the film the participants were asked to complete the demographics survey. When the film was over the participants were then asked to take a second memory assessment and math

test. For the second round the math test was given first, then the memory assessment. The participants were debriefed by student email to avoid contamination. Participants were thanked for their participation and were dismissed.

Design

A correlational and experimental design were used for the present study. To test the main hypothesis, an independent groups design was used. The pre-test was given to everyone without being broken into groups. The participants were then broken into two different conditions (Caffeinated or Decaffeinated). Conditions of the study were a counterbalanced memory assessment and math test for the pre-test and a math test and memory assessment for the post-test. A correlational design was used to determine if there was a relationship between GPA and caffeine consumption.

Results

An independent samples *t*-test was conducted to compare the memory assessment scores for group 1 (caffeinated) and group 2 (decaffeinated). The dependent variable was the memory assessment scores for the pre-test and post-test. The pre-test results indicated that the caffeinated group scored higher (M=6.4, SD=1.95) than the decaffeinated group (M=6.0, SD=1.89). However, this difference was not statistically significant. The post-test caffeinated group (M=8.8, SD=1.68) was significantly higher ($t(19)=2.40, p<.05$) than the mean of the decaffeinated group (M=7.0, SD=1.73).

The math pre-test results for the caffeinated group (M=13.7, SD=2.21) and decaffeinated group (M=14.18, SD=1.83) were not significant. The post-test results of the caffeinated group (M=14.30, SD=2.21) and decaffeinated group (M=13.72,SD=3.13) were also not significant.

The hypothesis that caffeine will enhance performance on memory assessment was supported. However, caffeine did not enhance performance on the math test. The memory assessment results are consistent with past research that the low dose would enhance memory.

A correlation was performed to see if there was a relationship between GPA and caffeine consumption patterns. There was a positive statistically significant relationship between GPA and how often participants consume caffeine; $r(19)=.52$, $p=0.005$. Participants who reported a higher GPA also reported consuming more caffeine. The hypothesis was there will a positive correlation between GPA and caffeine consumption was supported.

Discussion

Results provide partial support for the hypothesis that caffeine would enhance short-term memory. Overall several findings were consistent with prior research. Past research has shown that caffeine can either increase performance (Mitchell and Redman, 1992; Kerr Sherwood and Hindmarch, 1991; Hindmarch, 1998; Smith et al.,1990; Warburton, 1995; Durlach, 1998; Terry and Phifer, 1986; & Walker 2001), or decrease performance (Foreman 1999) or both (e.g. an inverted U shape in performance) (Loke 1990). The conflicting findings suggest a mediating variable, which may be dosage.

The current study has several strengths and limitations. One limitation was a small number of participants, which effects external validity. Another limitation was the math assessment. The math assessment did not have significant results for post-test due to the task difficulty and time to complete. The math test was 15 two-digit addition problems. This does not mean that the math assessment should not be used for future research, but possible adjustments to the

difficulty of the test or shortening time may make a difference.

Overall, several of the findings were consistent with prior research. Using a low-dose instead of a higher dose shows that a higher dose does not always provide greater performance as noted in past research. Most college students think that drinking larger amounts of caffeine will heighten performance. However, this is not the case.

Appendix A

Sample Items:
Demographic Characteristics
Age/Classification/Sex
GPA:

Do you regularly consume caffeine? O Yes O No

How many times a week do you consume caffeine? _____

Appendix B

Math Test
Addition, Third Grade Elementary Level (Vertical)

12 +45	35 +14	10 +88	40 +10	35 +41
55 +45	7 8 +56	4 3 +56	34 +65	54 +21

Memory Assessment

Kitten
Romans
Hooter
Detail
School

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