The effect of caffeine on learning and memory on three cognitive tasks in human subjects

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Purpose

This experiment was designed to determine if arousal from caffeine affects learning and memory of tasks that differ in complexity. College students, faculty, and community members learned three cognitive tasks after consuming either water or caffeinated coffee. Memory was assessed 24 hours later.

Background

The Yerkes-Dodson Law states that moderate arousal will yield optimal mental performance (Teigen, 1994). However, new literature has introduced the ‘task difficulty hypothesis’ that suggests the type of task also plays a role in that there is a negative relationship between arousal and task difficulty (Anderson, 1994; Watters, Martin, & Schreter, 1997). Caffeine is the most widely used psychoactive drug and a drug of choice among college students (Norton, Lazev, MacKenzie, & Sullivan, 2011). Caffeine is a central nervous stimulant that inhibits the fatigue-inducing effects of adenosine (Smith, 2002). Typically caffeine has been used to demonstrate the Yerkes-Dodson Law through tasks of varying difficulty that assess reaction time and correct responses in single-session trials (Anderson, 2004; Watters, Martin, & Schreter, 1997). However, there is an absence in the literature concerning how the Yerkes-Dodson Law relates to learning and memory.

Methods

Participants:

Participants (N=16) were randomly assigned into two groups:

- Water (n=7)
- Caffeine (n=9)
- Participants in the water group drank water before learning on the first day and participants in the caffeine group drank caffeinated coffee before learning on the first day.

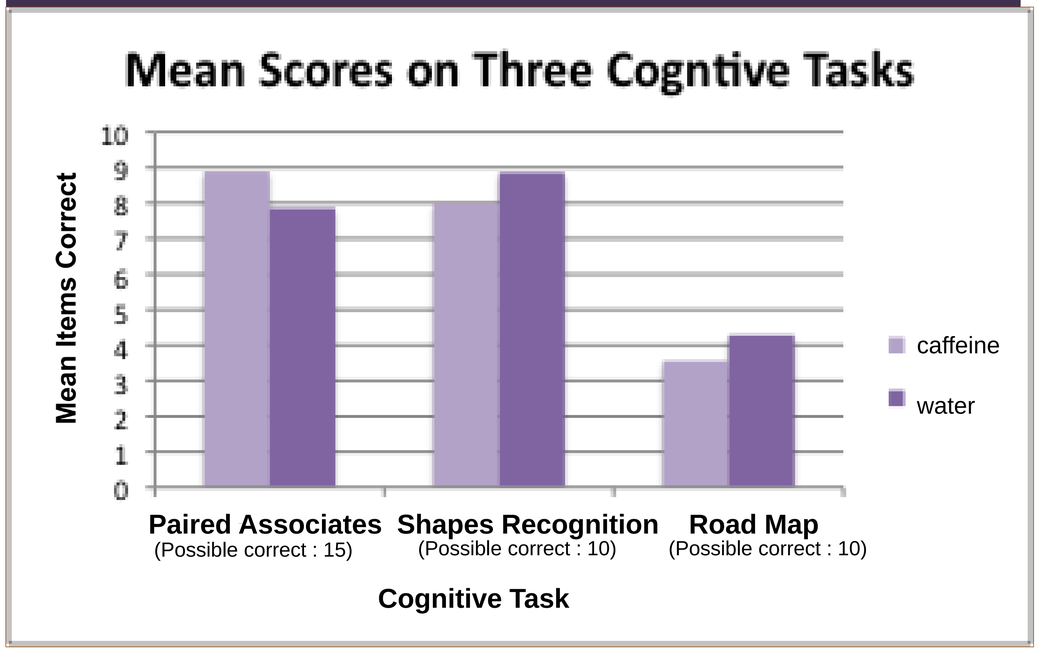
Drug & Materials:

- 250 mg of powdered caffeine, a moderate dose that would be expected in any medium serving of coffee, was dissolved in decaffeinated coffee. Plain water was served warm to control for temperature.
- The first task was a paired associates task, in which participants were asked to memorize 15 word pairs and 24 hours later recall words missing from each pair. This task is of moderate difficulty.
- The second task was a shapes recognition task, in which participants were asked to memorize 10 shapes and identify 24 hours later which of the 20 shapes presented were learned the first day. This task is the least difficult of the three.
- The third task was a spatial recognition task, in which 10 cities were shown on a map and 24 hours later participants labeled the map with the cities that were presented the day before. This task is the most difficult.

Procedure:

- During the first session, subjects read and signed consent forms, filled out caffeine history questionnaires, and were instructed to finish their beverages within 10 minutes.
- Subjects then waited 25 minutes to begin the three cognitive tasks, a delay which has been shown to allow plasma levels of caffeine to reach sufficient levels to have effect (Liguori, Hughes, & Grass, 1997)
- On the first day, participants learned the cognitive tasks and on the second day memory of the tasks was assessed.

Results



Condition	n	Paired Associates task mean/SD	Shape Recognition task mean/SD	Road Map Task mean/SD
caffeine	9	8.89/1.54	8.00/2.69	3.56/1.81
water	7	7.86/2.97	8.86/1.57	4.29/2.36

Recall and recognition scores of the three cognitive tasks served as the dependent variables and the randomly assigned drug condition served as the independent variable in independent samples t-tests.

There was no significant difference in the score for caffeine groups (M=8.89, SD=1.54) and water groups (M=7.86, SD=2.97) for the paired associates recall task; t(14)=.904, p=.381.

There was no significant difference in the score for caffeine groups (M=8.00, SD=2.69) and water groups (M=8.86, SD=1.57) for the shapes recognition task; t(14)=-.746, p=.468.

There was no significant difference in the score for caffeine groups (M=3.56, SD=1.81) and water groups (M=4.29, SD=2.36) for the road map spatial task; t(14)=-.702, p=.494.

Conclusions

Due to low sample sizes, there were no significant results. However, non-significant trends were identified showing that the group that received caffeine performed slightly better than the participants that received water on the task of moderate difficulty. The trends were opposite for the easy and difficult tasks.

Future Directions

Sample sizes will be broadened in order to find significant results. More levels of caffeine will be incorporated (150 mg and 300 mg) in order to vary the level of arousal in addition to the task difficulty.

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