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CAFFEINE, CHOCOLATE, PERFORMANCE AND MOOD

Name of 1St Author:Sudhir* garje
Name of 2ndAuthor: Krushna* Ghodke
Name of 3rd Author:prathmesh Gadiwan
Name of 4thAuthor:Sudam Gadade
Name of college :shivajirao Pawar Collge Of Pharamcy Pachegaon
Tal.Newasa Dist.A Nagar .413725

ABSTRACT

Background:

There has been considerable research on the effects of caffeine on performance and mood. This means that it can now be used as a positive control to benchmark the effects of less studied foods and drinks. Chocolate has been less frequently investigated, and the present study examined the effects of caffeine given in coffee and dairy milk chocolate in the same experiment.

Methods:

A parallel groups design was used to investigate the effects of 60 mg caffeine given in coffee and dairy milk chocolate. Forty-eight participants completed the study,which involved a practice session and two test sessions before and after the caffeine/chocolate manipulations. The test battery involved mood rating and performance tasks measuring a variety of functions (motor, episodic memory, working memory and attention). Participantseither carried out the sessions in the morning (10.30 start) or afternoon (15.30 start). Impulsivity scores were recorded before the start of the study.

Results: Caffeine was associated with feeling more clumsy but more efficient. The effect of chocolate on mood varied with the time of testing. Those given chocolate in the afternoon felt more friendly, quick-witted and excited than the no chocolate group. This pattern of results was reversed for the morning groups. Chocolate had no effects on the performance tasks. Selective effects of caffeine were observed, with no effect on the motor or episodic memory tasks but the faster performance of the logical reasoning task after caffeine. Interactions between caffeine and impulsivity were found in the search and memory speed and Bakan accuracy analyses. High impulsive participants showed worse performance than low impulsive people in the decaffeinated conditions, and the opposite was found after caffeine.

Conclusion:

These results demonstrate that, compared to caffeine in coffee, dairy milk chocolate produces fewbehavioural changes. The effects of caffeine were dependent on the type of task and personality, which confirms earlier research using similar methodology.

KEYWORDS:

Caffeine; chocolate; impulsivity; time of day; motor tasks; free recall; logical Reasoning; search and memory task; Bakan vigilance task.

NTRODUCTION:

The behavioural effects of caffeine are well documented.[1-7] This means that caffeine can be Used as a positive control and benchmark in studies investigating aspects ofourdiethathaveReceivedlessattention. Chocolate is widely consumed, and there have been studies examining Its effect on mood and performance. A systematic review[8] identified eight relevant studies. Some of this research has investigated components of chocolate (e.g., cocoa flavanols or Methylxanthines) rather than chocolate itself. Five of the studies showed an improvement in Mood or attenuation of negative mood seen in the control condition. The literature was unable To distinguish between mood changes due to the sensory characteristics of the chocolate or Pharmacological effects of the constituents. Improved cognitive function was most readily Observed after cocoa flavanols and methylxanthines. The authors of the review conclude by Stating that further research on the cognitive effects of chocolate is required. Indeed, most Studies have focused on the acute effects of chocolate. In contrast, there is evidence that Longer-term consumption of chocolate may lead to reduced

wellbeing.[9]Chocolate contains both caffeine and theobromine (20mg caffeine and 250 mg theobromine In 60 g dark chocolate, and 8mg caffeine and 100 mg theobromine in milk chocolate). Research[10] has shown that these doses of methylxanthines can lead to improved cognitive Performance and alertness compared to white chocolate or water. The present study Continued this line of research and compared consumption of dairy milk chocolate with Ingestion of caffeine in coffee.The research also examined individual differences in the effects of caffeine and chocolate. The study was based on earlier research[11] which examined the effects of time of day andImpulsivity. The results of this earlier study showed that some effects of caffeine were Independent of time of testing and impulsivity. Other tasks showed that high impulsive People performed worse in the decaffeinated condition but better in the caffeinated condition. The interactions between caffeine, impulsivity and time of day depended on the dose of Caffeine and type of task. The present study examined the dose of caffeine, with the caffeinated coffee containing more caffeine than the chocolate. A range of taskswas used in the study. Some tasks (motor tasks and episodic memory) were not expected to show significant effects of caffeine. Other tasks (e.g., logical reasoning) were predicted to show the main effects of caffeine but no interaction with impulsivity or time of day. Memory-loaded search and attention tasks were predicted to show interactions between caffeine and impulsivity.

METHODS:

The research reported here was carried out with the informed consent of the participants and With the approval of the ethics committee, Department of Psychology.

Design:

A parallel groups design was used with participants being assigned to one of four groups (decaffeinated coffee, no chocolate; caffeinated coffee, no chocolate; decaffeinated coffee, Chocolate; caffeinated coffee, chocolate). Half of each group were tested at 10.30 and a half At 15.30. There were approximately equal numbers of high and low impulsive participants (categorised on the Eysenck Personality Inventory.[12] Before the test sessions, the volunteers Were practised at the tasks. A baseline session was carried out before the ingestion of drinks And chocolate. Data from this session were used as covariates in the analysis of the post-Drink/chocolate data. The caffeine in the coffee was double-blind, with neither the Experimenters nor the participants knowing whether they had

caffeinated or decaffeinated Products. The post-drink session occurred approximately 60 minutes after consumption of the Coffee/chocolate.

Participants:

The participants were 48 subjects, half male, aged been 18 and 25 years. They were paid for participating in the study.

Coffee and Chocolate:

Participants were given instant decaffeinated coffee, and 60 mg caffeine was added to this in the caffeine condition. Those given chocolate had nine squares of dairy milk chocolate (43 g, 230 kcal, 26g carbohydrate, 13 g fat, and 3 g protein). Those in the no chocolate condition were given the chocolate at the end of the study.

Mood Rating and Performance tasks

Mood rating :

Prior to each performance-testing session, participants rated their mood using visual analogue scales. They were shown 18 pairs of adjectives (Drowsy/Alert; Relaxed/Excited; Strong/Feeble; Muzzy/Clearheaded; Well-co-ordinated/Clumsy; Lethargic/Energetic; Contented/ Discontented; Troubled/tranquil; Mentally-slow/Quick-witted; Tense/Calm; Attentive/Dreamy; Incompetent/Proficient; Happy/Sad: Antagonistic/Friendly: Interested/Bored; Withdrawn/Sociable: Depressed/Elated: and Self-centred/ Outward-going) with each pair being separated by a l0-cm line and rated how they felt at the time by putting short vertical strokes on the lines.

Motor tasks

Fixed fore-period simple reaction time task :

A square was displayed in the centre of a computer monitor. A warning tone sounded and was followed by the appearance of a black spot in the centre of the square. As soon as the volunteer detected the spot, a response had to be made as quickly as possible by pressing a specific key on the computer keyboard with the forefinger of the dominant hand. The time interval between the tone and the spot was two seconds. Each volunteer carried out 20 trials in each testing session, and the mean reaction time was recorded. If the person pressed the key before the spot appeared, the trial was ended, and the warning tone sounded again

Square pursuit tracking task :

A square moved in a clockwise direction in a regular path on the screen. The volunteer controlled a cross on the screen with a joystick, the aim being to make as many contacts with the square as possible. This task lasted for one minute, and the number of contacts made during this time was recorded.

Pegboard test:

This test involved transferring pegs from a full pocket-solitaire set to an empty one. Pegs were transferred one at a time from the full set to the equivalent hole in the empty set. The participants were instructed to use their dominant hand. For right-handed people, the full set was on the left and the empty set on the right. The first peg to be moved was the one at the extreme top right, and the volunteer went down each column, ending with the peg in the extreme bottom left of the set (left-handed volunteers had the full set on the right and proceeded from left to right rather than right to left).

Episodic memory

Free recall task :

The person was shown a list of 20 words, and each word was presented for 2 seconds. There was a 1-minute period for recall. The volunteer was allowed to recall the words in any order. The timing and presentation of the stimuli were controlled by the computer. Different lists of words were used on each occasion

Working memory

Logical reasoning task:

A syntactic reasoning test was used. This test involves verifying statements ranging in complexity from simple active to passive negative. Each statement relates the order of the letters A and B (e.g., ‘A follows B’) and is followed by either the letters AB or the letters BA. The participant had to read the statement, look at the order of letters, and then decide whether the statement was true or false. Each participant was given five practice statements prior to completing 32 statements.

Search and Memory task:

This task involved searching six lines of 60 letters for the presence of any of the five target letters printed at the start of each line. When the person detected a target, they crossed it out. There were 0-3 targets per line, and the mean number of targets per 6-line block was 9·6 (range= 7-12). They were instructed to scan in

a left-to-right directioal and told that they were not to re-check lines. They carried out a different version of the test on each occasion.

Bakan task:

A computerised version of the Bakan vigilance task was used. In this task, they were shown digits one at a time on the screen and had to detect sequences of three consecutive odd or three consecutive even digits. When such a sequence was detected, they pressed a key on the computer keyboard as quickly as possible. The digits were presented at the rate of one a second. The task lasted for 4 minutes, and there was a 1-minute practice session prior to the test. data. The second series of analyses replacing time of day with impulsivity was then carried out

RESULTS:

In the first series of analyses, the between-subject factors were caffeine, chocolate, and time of day. Analyses of covariance with the baseline data as covariates were performed on the data. The second series of analyses replacing time of day with impulsivity was then carried out.

Mood Effects of caffeine :

Those given caffeine felt significantly more clumsy ($p < 0.05$) but more proficient ($p < 0.05$). These effects are shown in Table 1 (high scores = more clumsy, more proficient)

Table 1: Effects of caffeine on mood (scores are the adjusted means). No caffeine Caffeine Clumsy 40.2 48.3

	No caffeine	Caffeine
Clumsy	40.2	48.3
Proficient	38.2	44.2

None of the other ratings showed a significant effect of caffeine. There were no significant interactions between caffeine, chocolate, time of day and impulsivity.

Effects of chocolate:

The effects of chocolate depended on the time of day at which it was eaten. In the morning, those who ate chocolate felt more relaxed, mentally slow, and antagonistic (all p's < 0.05). This pattern was reversed in the afternoon. These results are shown

Table 2. Effects of chocolate and time of day on mood (scores are the adjusted means).

	No chocolate am	No chocolate pm	Chocolate am	Chocolate pm
Relaxed/excited	58.3	42.8	47.0	65.0
Mentally slow/quick witted	61.7	54.6	54.4	65.3
Antagonistic/Friendly	67.3	58.6	53.5	67.6

Performance Caffeine:

There was a significant main effect of caffeine (p < 0.01) on the speed of completing the logical reasoning task (No caffeine: mean = 131.9-sec caffeine: mean = 118.1 sec). There were no significant effects of caffeine on the motor tasks or the episodic memory task

There were significant interactions between caffeine and impulsivity (all p's < 0.05) in the search and memory speed and Bakan accuracy scores. As predicted, high impulsive participants were worse in the no caffeine condition but better in the caffeine condition. These results are shown in

Table 3: Effects of caffeine and impulsivity on Search and Memory Speed and Bakan task accuracy (scores are the adjusted means).

	No caffeine/ low impulsivity	No caffeine/high impulsivity	Caffeine/low impulsivity	Caffeine/high impulsivity
Search and memory speed (secs)	109.0	131.0	122.0	114.0
Bakan mean hits per minute (maximum = 6)	5.85	5.50	5.50	5.90

Chocolate :

There were no significant effects of chocolate on performance. There were also no significant interactions between caffeine, chocolate, time of day and impulsivity.

DISCUSSION :

The present study obtained two main results. First, consumption of dairy milk chocolate had little effect on performance and mood. In contrast, caffeine in coffee had selective effects on mood and performance, with the outcomes depending on the type of task and the impulsivity of the participant. The absence of effects of chocolate agrees with some previous studies,[8] and it appears that cocoa and flavanols lead to greater effects than chocolate per se. Similarly, dark chocolate produces greater effects than dairy milk chocolateThe profile of the effects of caffeine agrees with earlier findings. There were no significant effects on motor tasks or episodic memory. Consumption of caffeine did lead to faster performance on a logical reasoning task confirming previous findings. In tasks where the location or timing of the target was unknown (the search and memory task and the Bakan task), caffeine interacted with impulsivity. High impulsive participants were worse than low impulsive people in the no caffeine condition, with the reverse being observed when caffeine was ingested.

Other research has failed to find these interactions, which may reflect differences in the tasks or the dose of caffeine. Some studies[13,14] have found interactions between caffeine x time of day x impulsivity x memory load. These were not observed here or in previous similar research.[11] This could reflect differences in the time of testing, with the states associated with early morning and early evening being different from mid-morning and mid-afternoon.

CONCLUSION:

The results of the present study show that, compared to caffeine in coffee, dairy milk chocolate produced few changes in performance and mood. The caffeine effects varied with the type of task and impulsivity, which confirms findings from previous research using similar methodologies.

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