Pharmacology Biochemistry and Behavior, Vol. 46, pp. 463–465, 1993
Printed in the U.S.A.

0091-3057/93 $6.00 + .00

RAPID COMMUNICATION

Antagonistic Effects of Caffeine and Alcohol on Mental Performance Parameters

M. HASENFRATZ,[1] A. BUNGE, G. DAL PRÁ AND K. BÄTTIG

Comparative Physiology and Behavioral Biology Laboratory, Swiss Federal Institute of Technology, ETH-Zentrum, Turnerstr. 1, CH-8092 Zürich, Switzerland

Received 7 April 1993

HASENFRATZ, M., A. BUNGE, G. DAL PRÁ AND K. BÄTTIG. *Antagonistic effects of caffeine and alcohol on mental performance parameters.* PHARMACOL BIOCHEM BEHAV 46(2) 463–465, 1993.—Scientific experiments done so far allow no clear conclusions about the popular belief that freshly brewed coffee can offset the debilitating effects of alcoholic intoxication. This question was addressed using a computer-controlled and subject-paced rapid information processing task (RIP) which was shown earlier to be sensitive to psychoactive substances. Nine male students were tested in a Latin square design before and after the intake of 3.3 mg/kg caffeine (or placebo) followed by 0.7 g/kg alcohol (or placebo). Whereas the mean RIP-task processing rate and the mean reaction time were impaired by alcohol and improved by caffeine, no changes were observed after the combination of alcohol and caffeine. Thus, it was concluded that under the tested conditions, caffeine was able to offset the debilitating effects of alcohol.

Alcohol Caffeine Mental performance Reaction time

A POPULAR belief is that freshly brewed coffee can offset the debilitating effects of alcoholic intoxication. Fudin and Nicastro (4), who reviewed a series of experiments done between 1935 and 1983, all of which addressed this question, concluded that no clear conclusions can be drawn from scientific experiments done so far. The reasons proposed by the two authors for the lack of clear conclusions are that there is a great variability in the dosages of caffeine and alcohol, in the tasks used, and also in the order and time intervals of the two treatments. Whereas caffeine was always given after alcohol, the interval in between ranged from 0 (drugs taken simultaneously) to about 45–55 min. However, no study investigated the effects of the inverse order, i.e., caffeine given before alcohol.

Concerning drug dosages and the task selection for future experiments, Fudin and Nicastro proposed that it would be necessary to use a task that is known to be impaired by alcohol and improved by caffeine and that the dosages used should be at the lowest levels needed to produce significant impairments or improvements relative to baseline.

As a part of a study investigating the interactive effects of caffeine, alcohol, and antihistamines (2,3), we also investigated the interactive effects of caffeine and alcohol on mental performance without any other treatment. These data are presented in the present paper as a separate Latin square design study. The subject-paced rapid information processing task (RIP) used was found earlier to be impaired after 0.7 g/kg alcohol (7) but improved after caffeine in different dosages (1, 6). Further, in contrast to the earlier studies [as reviewed by Fudin and Nicastro (4)] the caffeine treatment preceded the alcohol treatment.

METHOD

Subjects

The subjects were nine healthy undergraduate male students with a mean age of 24.7 years (range 23–29) and a mean body weight of 78.3 kg (60–96). They were moderate coffee and alcohol consumers [mean self-reported coffee consumption = 1.5 cups/day (1- 8); mean self-reported alcohol consumption = 3.6 times/week a beer or a glass of wine (1–7)], nonsmokers or occasional smokers (less than five cigarettes per day), and they reported being in good health and not undergoing medical treatment. Prior to all sessions they were requested to abstain from smoking, from drinking alcohol- and caffeine-containing beverages for at least 12 h, and from eating breakfast on test mornings. They received a fixed sum for the completion of all sessions.

[1] To whom requests for reprints should be addressed.

TABLE 1

BLOOD ALCOHOL CONCENTRATIONS [%] AS MEASURED AT 30 AND 80 MIN AFTER THE BEGINNING OF DRINKING, MEAN DIFFERENCES AND RESULTS OF PAIRED *t*-TEST COMPARISONS BETWEEN THE TWO TREATMENTS

	Alcohol Alone	Alcohol and Caffeine	Mean Difference	t	p
30 min after the beginning of drinking	0.038 ± 0.018	0.026 ± 0.011	0.012 ± 0.014	2.42	<0.05
80 min after the beginning of drinking	0.046 ± 0.008	0.031 ± 0.014	0.014 ± 0.016	2.56	<0.05

n = 8.
Mean ± SD.

Treatments

The coffee (1 cup) was prepared with decaffeinated coffee with or without an additional 3.3 mg/kg caffeine. The alcoholic beverage (3 dl) consisted of orange juice with gin flavoring and either 1 ml on the surface (placebo) or 0.7 g/kg ethanol 96%. The blood alcohol concentrations were assessed just before and after the second RIP trial (30 and 80 min after the beginning of intake) with a breath alcohol analyzer (ATC1, Joma Trading AG).

Task

The rapid information processing task (RIP) was used as in earlier studies (5–7). In this task the subjects had to press the response key as rapidly as possible after the detection of a target. A target was a sequence of three consecutive odd or even digits in a sequence of pseudorandomly presented digits (1–8). The initial presentation rate was 90 digits/min. Thereafter, the interdigit interval decreased in steps of 33 ms after each correct response (hits) and increased in identical steps after each error (commissions and omissions). The processing rate (number of digits processed per time unit) and the reaction times for hits were analyzed as indices of performance.

Design and Procedure

After a training session, where the subjects practiced the RIP task three times, all subjects took part in 10 test sessions, four of which were relevant for the present 2 × 2 crossover design study.

At the beginning of a test session, a first 5-min rest phase was recorded and then the 20-min pretreatment RIP task trial was performed. After a further 5-min rest phase the subjects received a standardized light breakfast consisting of cottage cheese, Darvida crispbreads, and a cup of coffee (with or without caffeine according to the design). Ten minutes later they received the alcoholic beverage, which was to be drunk within 30 min. Then, the blood alcohol concentration was measured and the same procedure was repeated as before the treatment.

Data Treatment and Statistics

The continuously recorded processing rate and the reaction time to correct responses were aggregated for consecutive 5-min means. These data were then submitted to 2 × 2 × 2 × 4 ANOVAs with the factors caffeine (C: 0 vs. 3.3 mg/kg), alcohol (A: 1 ml vs. 0.7 g/kg), prepost (P: pre- vs. posttreatment trial) and block (B: four consecutive 5-min blocks of each trial). As the factor block showed no significant interaction with the relevant treatment factors (and interactions), the mean pre- to posttreatment differences were computed and reanalyzed with a 2 × 2 ANOVA with the factors caffeine (C) and alcohol (A).

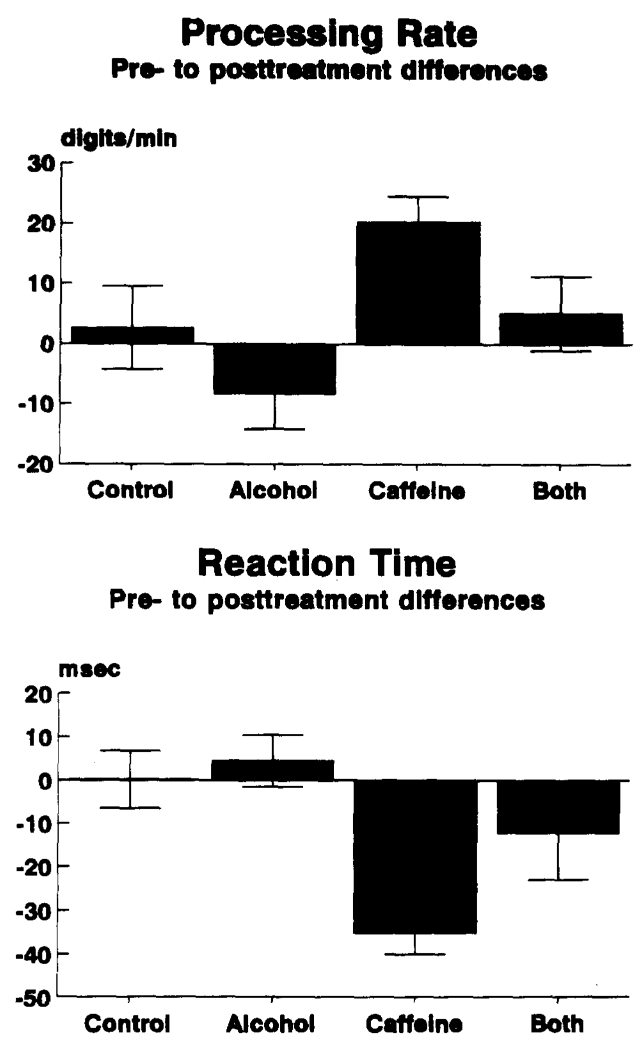

FIG. 1. Mean pre- to posttreatment differences for the two mental performance parameters of the RIP task.

RESULTS

Whereas the mean blood alcohol concentrations (as presented in Table 1) still increased from the first to the second assessment, they were significantly smaller after the caffeine than after the placebo pretreatment.

As shown in Fig. 1, the reaction time and processing rate were affected by alcohol alone and by caffeine alone. Caffeine reduced reaction time, $F(1, 8) = 20.37$, $p < 0.01$, and increased processing rate, $F(1, 8) = 5.39$, $p < 0.05$. The alcohol-induced impairments, on the other hand, reached significance for reaction time, $F(1, 8) = 5.71$, $p < 0.05$, but not for processing rate, $F(1, 8) = 3.19$, NS). However, the combination of the two treatments was additive, as seen in Fig. 1 and confirmed by the nonsignificance of the A × C interactions [reaction time: $F(1, 8) = 0.88$, NS; processing rate: $F(1, 8) = 0.44$, NS].

CONCLUSIONS

Although the effects of alcohol alone were very weak because of the rather low blood alcohol concentrations [which were clearly below the car driving limit (0.08%) of many countries], the task used in the present study met the requirements for testing the antagonistic effects of caffeine and alcohol as proposed by Fudin and Nicastro (4). Qualitatively, caffeine improved and alcohol impaired both assessed performance parameters of the RIP task. The combination of the two treatments led to an addition of these two effects, indicating that caffeine was able to offset the debilitating effects of the alcoholic beverage under these conditions. Considering the reduced blood alcohol concentrations after caffeine pretreatment, it can be concluded that caffeine antagonized the effects of alcohol, in part, also by reducing the absorption of alcohol. However, this can only be effective if caffeine is ingested before absorption of the alcohol is completed. As reviewed by Fudin and Nicastro (4), all studies gave the two substances either simultaneously or caffeine after alcohol, which led to equivocal results. Thus, the order of the treatments might play an important role. However, to validate this hypothesis further investigations comparing the two treatment orders in separate experiments would be needed.

REFERENCES

1. Bättig, K.; Buzzi, R. Effect of coffee on the speed of subject-paced information processing. Neurospychobiology 16:126–130; 1986.
2. Bunge, A. Antihistamines and caffeine: Physiological and psychomotor effects. Unpublished diploma thesis from the Swiss Federal Institute of Technology, Zürich; 1992.
3. Dal Pra, G. Antihistamines and alcohol: Physiological, subjective and performance effects. Unpublished diploma thesis from the Swiss Federal Institute of Technology, Zürich; 1992.
4. Fudin, R.; Nicastro, R. Can caffeine antagonize alcohol-induced performance decrements in humans? Percept. Motor Skills 67:375–391; 1988.
5. Hasenfratz, M.; Bättig, K. No psychophysiological interactions between caffeine and stress? Psychopharmacology (Berlin) 109: 283-290; 1992.
6. Hasenfratz, M.; Jaquet, F.; Aeschbach, D.; Bättig, K. Interactions of smoking and lunch with the effects of caffeine on cardiovascular functions and information processing. Hum. Psychopharmacol. 6: 277–284; 1991.
7. Michel, C.; Bättig, K. Separate and combined psychophysiological effects of cigarette smoking and alcohol consumption. Psychopharmacology (Berlin) 97:65–73; 1989.