ARTIKEL PENELITIAN

The Effects of Caffeine on Mood and Cognitive Performance

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ABSTRAK

Kafein adalah stimulan psikoaktif yang banyak dikonsumsi dan memengaruhi otak serta sistem saraf. Penelitian ini menggunakan desain acak, *double-blind*, dan antar-subjek untuk mengkonfirmasi pengaruh kafein terhadap *mood* dan performa kognitif. *Mood* diukur menggunakan *Profile of Mood States* dengan fokus pada depresi dan ketegangan, sedangkan performa kognitif diukur menggunakan *Parametric Go/No-Go* dengan fokus pada waktu reaksi dan akurasi identifikasi target. Penelitian ini melibatkan 55 partisipan berusia 19 hingga 49 tahun. Partisipan tidak mengkonsumsi kafein enam jam sebelum sesi penelitian. Sebanyak 30 partisipan menerima 200mg kafein dan 25 partisipan menerima plasebo dengan 0mg kafein. Hasil penelitian menunjukkan bahwa kafein tidak berpengaruh signifikan terhadap depresi, ketegangan, dan akurasi identifikasi. Namun, kelompok kafein menunjukkan waktu reaksi yang lebih cepat secara signifikan dibandingkan kelompok plasebo. Temuan ini menunjukkan bahwa kafein dapat meningkatkan waktu reaksi pada beberapa orang, tetapi tidak memengaruhi *mood* atau performa kognitif.

Kata kunci: *Kafein, Mood, Performa Kognitif*

ABSTRACT

Caffeine is a widely consumed psychoactive stimulant that affects the brain and nervous system. This study used a double-blinded, randomised, between-subjects design to confirm the effects of caffeine on mood and cognitive performance. Mood was assessed using the Profile of Mood States, focusing on depression and tension. Cognitive performance was assessed using the Parametric Go/No-Go task, focusing on reaction time and target identification accuracy. This study included 55 participants aged 19 to 49 years. Participants abstained from caffeine consumption six hours prior to the session. Thirty participants received 200mg of caffeine, while 25 received placebo of 0mg caffeine. Results showed no significant effects of caffeine on depression, tension, and identification accuracy. However, the caffeine group demonstrated significantly lower reaction times than the placebo group. These findings suggest that caffeine may enhance reaction time in some individuals, but does not influence mood or cognitive performance.

Keywords: *Caffeine, Cognitive Performance, Mood*

INTRODUCTION

Caffeine (1,3,7-trimethylxantine) is a psychoactive stimulant that acts on the central nervous system (CNS) and has the potential to influence mood and cognitive performance (Fiani et al., 2021; Heckman et al., 2010). Its primary mechanism involves being an antagonist of adenosine receptors, thereby inhibiting the action of adenosine, a neuromodulator associated with sedative effects (Doepker et al., 2016). This process is thought to allow caffeine to increase alertness, energy, and positive mood states, although it may also promote adverse outcomes, such as heightened anxiety and nervousness. In addition, adenosine antagonism also facilitates the synthesis of acetylcholine and glutamate (Boolani et al., 2020). Acetylcholine is crucial for attentional control and memory formation, while glutamate plays a central role in excitatory neural activity and cognitive processing.
Caffeine is widely consumed due to its diverse psychological and physiological impacts. Studies have shown that caffeine may enhance various aspects of cognition, including attention, memory, concentration, and decision making (Rauf et al., 2025). Beyond cognitive performance, it has also been associated with improved physical performance, such as increased endurance and strength, as well as enhanced fat metabolism through glycogenolysis stimulation (Einöther & Giesbrecht, 2013).

Given these perceived benefits, many adults consume caffeine to manage increasing cognitive, social, and occupational demands (Tavakkoli et al., 2024), often using it as a strategy to counteract fatigue and heavy workloads. Although moderate intake is generally considered safe, excessive consumption has been linked to adverse physical and psychological outcomes, such as sleep disturbances, anxiety, restlessness, and substance dependence (Reddy et al., 2024). Notably, the effects of caffeine vary according to factors, not limited to individual sensitivity, dosage, and administration form.

Past studies have examined the effects of caffeine on mood states and cognitive performance, however, findings remain inconsistent. Several studies have reported positive effects on mood and well-being (Boolani et al., 2020; Domínguez et al., 2021; Grant et al., 2018; Haskell-Ramsay et al., 2018), whereas others have found minimal or non-significant effects on mood outcomes (Distelberg et al., 2017; Giles et al., 2017). Variations in findings may stem from differences in study design, including sample characteristics, caffeine dosage, administration method, and outcome measures. These discrepancies inhibit conclusions regarding the extent to which caffeine can truly enhance psychological functioning.

In contrast, most research has shown caffeine to improve cognitive processes. Previous research demonstrated caffeine's ability to improve target identification accuracy, enhance reaction time in visual processing (Haskell-Ramsay et al., 2018), reduce mental exertion (Boolani et al., 2020; Domínguez et al., 2021), and improve working memory (Giles et al., 2017). Although these studies utilised different measurements and tasks, they consistently produced positive effects of caffeine on cognitive domains.

The lack of consensus in recent literature emphasises the need for further confirmation. Consequently, there remains a gap in understanding the specific conditions under which caffeine most effectively influences mood and cognitive performance. Addressing this gap is essential to clarify theoretical models and inform practical recommendations related to caffeine consumption.

The present study aims to explore the effects of caffeine on mood and to confirm its potential role in enhancing cognitive performance. Specifically, this study intends to investigate whether caffeine intake leads to improvements in mood states, as reflected by reduced levels of depressive symptoms and tension symptoms, and whether it enhances cognitive performance, as measured by reaction time and target stimuli identification accuracy. Accordingly, the hypotheses of this study are as follows: (i) Participants in caffeine condition would report significantly lower levels of depression scores than those in placebo condition; (ii) Participants in caffeine condition would report significantly lower levels of tension scores than those in placebo condition; (iii) Participants in caffeine condition would demonstrate significantly faster reaction times during the cognitive assessment compared to the placebo condition; and (iv) Participants in caffeine condition would demonstrate significantly higher

target stimuli identification accuracy during the cognitive assessment compared to the placebo condition.

METHODOLOGY

Research Design

This is an experimental quantitative study intended to test hypotheses and determine causal relationships using manipulations and statistical analyses. This study used a between-subjects design and randomised participants into either caffeine group or placebo group. This is done to ensure each participant will receive only one treatment condition, with the placebo group acting as a comparison group. It is also double-blinded, meaning both the researcher and participants were unaware of the group assignment.

Participant

This study used total sampling, where all participants were psychology students at the Queensland University of Technology enrolled in the PYB260 unit. Fifty five participants (M = 23, SD = 6.0) aged 19 to 49 years old participated in this study, including 49 female (89.1%) and 6 male (10.9%) participants. Participants were subject to a caffeine washout period for six hours prior to the session. In the beginning of the session, participants were verbally briefed regarding the details of the experiment.

Measurements

Caffeine intake has two conditions of 200mg capsule and 0mg placebo capsule. Mood is measured by depression and tension subscales of the Profile of Mood States for Adolescents (POMS-A). The POMS-A is a brief 24-item questionnaire of subjective mood states with 5 choices (1="not at all", 5="extremely"). The POMS has a good internal consistency (α=.84-.95), supported construct validity, good test-retest reliability (r=.65-.74), and good criterion validity (Searight & Montone, 2020). Changes in depression and tension are calculated by subtracting post-treatment mean scores by pre-treatment mean scores in each group.

Cognitive performance is measured using the Parametric Go/No-Go (PGNG) task, through the dimensions of reaction time and identification accuracy. In the PGNG task, participants are presented with a rapid stream of letters, in which they will be asked to respond to context-based target stimuli. The PGNG task for various cognitive performance measurements has a supported construct validity (Votruba & Langenecker, 2013). This experiment uses 2 targets with a contextual response rule, involving 276 trials. Response time of each group is measured in milliseconds and calculated by average. Target identification accuracy of each group is measured in percentage and calculated by average.

Data Analysis

Statistical analysis of quantitative data was conducted using SPSS to demonstrate descriptive statistics and inferential tests. A repeated measures t-test was utilised to compare the changes in scores due to caffeine in mood and cognitive performance. Participant scores in depressive symptoms, tension, reaction time, and target identification accuracy were compared in two treatment conditions.

RESULTS

A repeated measures t-test analysis was used to analyse score differences pre and post treatment in both caffeine group and placebo group. Descriptive statistics of mood showed that depression scores were found to be lower after treatment in both the caffeine group (M = -.40, SD = 1.28) and placebo group (M = -1.00, SD = 1.53). However, this decrease in depression was not statistically significant, $t(53) = 1.59$, $p = .100$, $d = 0.43$, 95% CI [-.16, 1.34]. Similarly, tension scores were also found to be lower after treatment in the caffeine group (M = -1.23, SD = 1.83) and placebo group (M = -1.16, SD = 2.12), and were not found to be statistically significant, $t(53) = -.14$, $p = .891$, d = -0.04, 95% CI [-1.14, .99].

In terms of cognitive performance, the reaction times of participants were observed to be significantly lower in the caffeine group (M = 420.94, SD = 20.09) compared to the placebo group (M = 430.49, SD = 14.06), $t(53) = -2.00$, $p = .044$, d = -0.54, 95% CI [-19.11, .02], with a medium effect size. Additionally, target identification accuracy was observed to be higher in the caffeine group (M = 67.78, SD = 16.85) compared to the placebo group (M = 59.15, SD = 220.85). However, this difference was not found to be statistically significant, $t(53) = 1.70$, $p = .096$, $d = 0.46$, 95% CI [-1.57, 18.82].

Table 1. t-test Results of Caffeine Conditions on Mood and Cognitive Performance Indicators

Indicators	Caffeine (200mg)		Placebo (0mg)		$t(53)$	p	Cohen's d
	M	SD	M	SD			
Depression Change	-.400	1.276	-1.000	1.528	1.588	.100	.430
Tension Change	-1.233	1.832	-1.160	2.115	-.138	.891	-.037
Response Time, in	420.940	20.085	430.490	14.056	-2.001	.044	-.542
Target Identification, in %	67.78	16.853	59.15	20.850	1.697	.096	.460

DISCUSSION

The findings of this study demonstrates that caffeine does not have a significant effect on both depression and tension, although mean scores for both variables were found to be lower in the caffeine group than in the placebo group. Similarly, caffeine did not significantly influence target identification accuracy, despite the caffeine group showing higher mean accuracy scores. However, those in the caffeine group were found to significantly exhibit faster reaction times when identifying stimuli compared to those in the placebo group. Overall, these results suggest that caffeine consumption does not meaningfully alter mood, particularly depression and tension, nor does it enhance cognitive performance beyond increasing reaction speed.

Previous literature has reported mixed findings regarding the effects of caffeine on mood. Some have identified positive mood-related outcomes (Boolani et al., 2020; Domínguez et al., 2021; Grant et al., 2018; Haskell-Ramsay et al., 2018), whereas others have identified adverse effects on mood and well-being (Distelberg et al., 2017). The present findings align with Giles et al. (2017)'s study, where the POMS scale was also employed, and found no significant effects of caffeine across its dimensions, including depression and tension. Additionally, the current study failed to replicate previously

demonstrated enhancing effects of caffeine on cognition (Boolani et al., 2020; Domínguez et al., 2021; Giles et al., 2017; Haskell-Ramsay et al., 2018).

Discrepancies between this study and those of Domínguez et al. (2021) may be attributed to differences in sample characteristics, particularly sample size and gender composition. The current study involved a larger, predominantly female sample, whereas Domínguez et al. (2021)'s study included only male participants. Gender-related differences in sensitivity to substance, metabolism rates, or physiological responses may therefore account for the observed variation. Furthermore, differences from Haskell-Ramsay et al. (2018)'s study may also be attributed to variations in participant age ranges, as broader age distributions can influence cognitive functioning and sensitivity to psychoactive substances. Finally, inconsistencies with Grant et al. (2018)'s study may be due to differences in caffeine dosage and administration method, as their study administered a higher total daily dose of 400mg in gum form, potentially resulting in different absorption rates and dosage effects.

The present study is most comparable to Distelberg et al. (2017) and Boolani et al. (2020) in the context of sample size, form of caffeine, age of participants, and methodological approach. Despite these similarities, comparable effects of caffeine were not observed. Considering various measures of mood and cognitive performance typically demonstrate good validity and internal reliability, these discrepancies may reflect context-dependent or inconsistent effects of caffeine. As such, this highlights the importance of examining and controlling additional moderating variables that may influence caffeine's impact on mood and cognition.

Efforts were made to control an extraneous variable, namely prior caffeine intake, by instructing participants to abstain from caffeine for a six hour washout period. A placebo condition was also implemented to enable direct comparison, while maintaining identical experimental procedures. However, unlike much existing literature that utilises multiple mood scales and cognitive tasks, this study relied solely on the POMS-A scale and one type of PGNG task, which may have limited the ability to observe changes. Additionally, the use of total sampling and convenience sampling of students, including predominantly small effect sizes, may restrict the generalisability of the findings to other populations. As the study only examined a single caffeine dose of 200mg, future research can explore varying dosages and longer observation periods to better understand the effects of caffeine on mood and cognitive performance.

CONCLUSION

This study aimed to address and confirm the effects of caffeine on mood and cognitive performance, where limited support for the proposition that caffeine produces meaningful psychological benefits was observed. The findings suggest that caffeine does not influence mood states, specifically depression and tension, and does not enhance cognitive performance in a broad sense. Instead, caffeine's effects appear to only manifest as faster reaction times without consequent improvements in psychological outcomes or cognitive accuracy.

These results emphasise the context-dependent nature of caffeine's effects and contribute in explaining inconsistencies in prior literature. Despite controlled experimental conditions, caffeine-related improvements do not generalise across various psychological dimensions. Further research should therefore explore moderating factors to better understand the conditions under which caffeine may produce meaningful and beneficial effects.

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CONFLICT OF INTERESTS DECLARATION

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