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The Effect of Taurine and Caffeine in Stroop Interference

Georgios Tzatzadakis[1], Louiza-Nektaria Moutaki[1], Andrianna Kapandriti[1], Ioannis Christoulakis[1], Georgia Iatrou[1], Athanasia Giannopoulou[1], Emmanouil Lydakakis[1], Georgios Pilafas[2,3], Penelope Louka[2,4,5]

[1]Student, University of Derby (UK) at Mediterranean College campus, Athens, Greece
[2]Accredited Lecturer, University of Derby (UK) at Mediterranean College campus, Athens, Greece
[3]Program Leader BSc (Hons) Applied Psychology, University of Derby (UK) at Mediterranean College campus, Athens, Greece
[4]Head of the School of Psychology, Mediterranean College, Athens Greece
[5]Deputy Head of Academic Affairs (Learning, Teaching & Assessment), Mediterranean College, Athens Greece

Corresponding Author: Georgios Tzatzadakis

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ABSTRACT

The Stroop test, created by John Ridley Stroop in 1935, is one of the most famous assessments of cognitive abilities related to inhibition and attention (Stroop, 1935). In this test, the participants must identify the color of the ink used to print words as rapidly as possible, irrespective of the content of the words. Based on the findings from previous studies, the administration of caffeine or caffeine and taurine may positively impact cognitive processes. It may improve cognitive control, reduce interference effects, and enhance task performance, such as the Stroop test. The present study investigates how caffeine and taurine affect cognitive processes, particularly selective attention. The independent variable (IV) is the consumption or non-consumption of one of the stimulants (caffeine or taurine), while the dependent variable (DV) is the time taken to complete the Stroop test. One-way ANOVA was used to compare the mean time to complete the Stroop test between the three groups (control, caffeine, and taurine). 60 participants took part in this experiment and completed the Stroop test according to a sequence allocation method, randomly assigning them to one of the three groups based on the independent variable level (IV) they were given (caffeine, taurine, or control[decaf]). This procedure ensured that the study was conducted standardized and ethically and that the data collected were valid and reliable. No statistically significant results were detected in the analysis $F(2,57)=0.801$, $p=0.454$. There was no post-hoc test, as there was no statistically significant difference.

Keywords: Stroop interference, Taurine, Caffeine, Decaffeinated, Greece

INTRODUCTION

The Stroop test, created by John Ridley Stroop in 1935, is one of the most famous assessments of cognitive abilities related to inhibition and attention (Stroop, 1935). In this test, the participants must identify the color of the ink used to print words as rapidly as possible, irrespective of the content of the words. The interference between the word's meaning and the ink color produces a cognitive conflict. Response times are measured to gauge participants' capacity to suppress automatic processing and exercise cognitive control. Since 1935, the test has been widely used to assess cognitive function and has been modified for other purposes. Several variations of the original Stroop test have been developed (Pantic et al., 2014; Williams et al., 1996). Moreover, the Stroop test is frequently employed in studies examining attention, inhibition, and executive function since it is regarded as a

valid and trustworthy indicator of cognitive processing (Golden & Freshwater, 2002). Furthermore, the Stroop test has been used to look at neurological illnesses, including traumatic brain damage (Chiaravalloti et al., 2002), mental problems like schizophrenia (Kerns et al., 1999), and cognitive changes related to aging (Verhaeghen & Cerella, 2002).

Kenemans et al. (1999) examined how caffeine affected cognitive regulation through the Stroop interference test. Twenty-four healthy adults participated in the study and completed the Stroop test after taking either a caffeine pill or a placebo. The results showed that the reaction times when performing the Stroop task were not significantly impacted by coffee ingestion, but the interference effect was reduced, indicating greater cognitive control. The scientists concluded that caffeine might enhance cognitive control.

One year later, Scholey et al. (2000) conducted a double-blind, placebo-controlled trial to investigate the effects of Bacopa monniera (Brahmi) extract on cognitive function in healthy human subjects. The study used a battery of cognitive tasks to assess cognitive function at baseline, 5 weeks, and 12 weeks. The Stroop test measured the participants' ability to inhibit automatic responses and focus on relevant information. According to the results, the group receiving Bacopa monniera showed improved cognitive function compared to the placebo group, significantly improving the Stroop test scores. More specifically, the Bacopa monniera group performed better on tests of verbal learning, memory consolidation, and information processing speed. That led the researchers in the conclusion that Bacopa monniera might have the potential as a natural treatment for cognitive dysfunction, including improving performance on tasks that require cognitive control.

Ten years later, Einöther et al. (2010) conducted a double-blind, placebo-controlled study to investigate the effects of L-theanine and caffeine on cognitive performance and subjective alertness in healthy adults. The Stroop test was one of the cognitive assessments in the study used to gauge participants' cognitive abilities. Participants were randomly assigned to receive a placebo, L-theanine, caffeine, or a combination of L-theanine and caffeine. The results showed that combining L-theanine and caffeine improved the subjects' cognitive abilities compared to the placebo and caffeine-alone groups. However, no significant effects were found for intersensory attention or subjective alertness. The scientists concluded that L-theanine and caffeine might benefit specific cognitive processes, including those measured by the Stroop test.

Childs et al. (2011) used the Stroop test to examine how caffeine and d-amphetamine affected participants' cognitive function when they were sleep deprived. After 36 hours of sleep deprivation, participants in a double-blind, placebo-controlled trial were randomly selected to receive either caffeine, d-amphetamine, or a placebo. The Stroop test measured cognitive ability, and some visual analog scales were used to measure mood. Compared to the placebo, the results demonstrated that coffee and d-amphetamine enhanced performance on the Stroop test and boosted alertness. However, compared to d-amphetamine, coffee had a more notable impact on mood. The scientists concluded that caffeine might be an effective remedy for cognitive deficiencies brought on by sleep deprivation.

Giles et al. (2012) investigated the individual and combined effects of caffeine, taurine, and glucose on cognitive performance in healthy young adults. The participants were given drinks with caffeine and taurine, glucose and taurine, caffeine and glucose, or a placebo. Fourteen activities were used to evaluate cognitive ability, including the Stroop test, Rapid Visual Information Processing, and Digit Span tasks. According to the findings, glucose, and taurine had no discernible effects on any of the cognitive activities, but

coffee dramatically enhanced performance on the Stroop task. Compared to caffeine alone, caffeine and taurine marginally sped up response times on the Stroop task, but this difference was not statistically significant. The scientists concluded that caffeine, rather than taurine or glucose, is the primary component of energy beverages that enhances cognitive ability.

Finally, almost eight years ago, Nešić et al. (2015) conducted a study to investigate the effects of caffeine and taurine on selective attention, alone and in combination. The study had 45 healthy adult participants with a double-blind, placebo-controlled methodology. Before completing a task requiring selective attention, the participants were given either caffeine, taurine, caffeine combined with taurine, or a placebo. Results showed that the group receiving caffeine and taurine exhibited better selective attention than the placebo group. However, neither caffeine nor taurine had any significant effect on their own. The researchers concluded that coffee and taurine together might be able to improve cognitive function for selective attention.

Based on the findings from previous studies, the combined administration of stimulants may positively impact cognitive processes. It may improve cognitive control, reduce interference effects, and enhance task performance, such as the Stroop test. These findings indicate that caffeine and taurine may synergistically and alone enhance cognitive function related to selective attention, The present study investigates how caffeine and taurine affect cognitive processes, particularly selective attention.

MATERIALS & METHODS

Design

The independent variable (IV) is the consumption or non-consumption of one of the stimulants (caffeine or taurine), while the dependent variable (DV) is the time taken to complete the Stroop test. One-way ANOVA was used to compare the mean time to complete the Stroop test between the three groups (control, caffeine, and taurine). One-way ANOVA was used because it is suitable for analyzing data from experiments with multiple groups or conditions. It allows testing for significant differences between the means of the groups. Andrew Field (2018) identified several assumptions that should be checked before conducting an ANOVA analysis: 1) Independence of observations: The observations should be independent of each other, meaning that the data points should not be related or dependent on each other. 2) Normality: The dependent variable should be normally distributed within each group or condition. This assumption was checked using a normal probability plot or a Shapiro-Wilk test. 3) Homogeneity of variances: The variances of the dependent variable should be equal across all groups or conditions. This assumption was checked using Levene's test or the Brown-Forsythe test. 4) Additivity and linearity: The dependent and independent variable(s) relationship should be additive and linear. This means that the effect of each independent variable should be independent of the levels of the other independent variables, and the relationship between the dependent and independent variables should be linear. 5) No significant outliers: Extreme values or outliers can affect the results of ANOVA.

Participants

60 participants took part in this experiment. There were 36 males and 24 females. The inclusion criteria were that all participants were coffee drinkers, between 18 and 60 years old, had good physical and mental health, and had no chronic medical conditions or serious illnesses. Moreover, all participants were fluent in English and provided written informed consent to participate in the study Their ages ranged from 18 to 49 years old. Participants were of various ethnicities. The mean age of the participants was 28 years old (SD= 8.4). Convenient sampling method was used as it allowed the researchers to recruit participants quickly and efficiently from a specific population. Convenience sampling

is a non-probability sampling method that involves selecting participants based on their availability and willingness to participate in the study (Creswell, 2014). This method is often used in research when it is difficult or not feasible to obtain a representative sample of the population of interest (Babbie, 2016). All participants were sampled from college, the work environment, and the family environment of the researchers.

Materials

The materials used in this experiment included a timer to measure the time taken to complete the Stroop test, a hard copy of the Stroop test itself, stimulants (caffeine and taurine) that were given to the respective groups of participants before the test, SPSS software for data analysis, a participant information sheet providing information about the study, a consent form that participants signed to indicate their willingness to participate, and a debrief sheet informing the participants about the purpose of the study, handed to them after the completion of the test. These materials were carefully selected to ensure that the experiment was conducted standardized and ethically and that the data collected were accurate and reliable.

PROCEDURE

The procedure for this experiment started with the creation of the incongruent Stroop test by the researchers. Once the test was created, the researchers designed ethics forms in accordance with the guidelines set out by the British Psychological Society (2018). These forms were approved by the Ethics Committee at Mediterranean College in Athens, Greece, and participants were recruited using a convenient sampling method. Before participation, each participant signed the approved ethics forms to provide informed consent and ensure that they were fully aware of the purpose and procedures of the study. Finally, participants completed the Stroop test according to a sequence allocation method, which randomly assigned them to one of the three groups based on the independent variable level (IV) they were given (caffeine, and taurine, or control). This procedure ensured that the study was conducted standardized and ethically and that the data collected were valid and reliable.

RESULT

A one-way ANOVA was performed between three groups: decaf (control), caffeine, and taurine. No statistically significant results were detected in the analysis F(2,57)=0.801, p=0.454. There was no post-hoc test, as there was no statistically significant difference.

More specifically, the effect on the subjects' cognitive function was not altered by any stimulants they consumed before taking the Stroop test.

	Sum of squares	df	Mean Square	F	Sig.
Between Groups	268,300	2	134,150	0,801	0,454
Within Groups	9550,033	57	167,544		
Total	9818,333	59			

DISCUSSION

The experiment investigated how coffee and taurine affect cognitive processes, particularly selective attention. The research used a one-way ANOVA to compare the three groups, decaf (control), caffeine, and taurine with caffeine. The results showed no statistically significant differences between the groups regarding cognitive function. Post-hoc tests were not conducted as no significant effects were observed. Therefore, the stimulants consumed before the Stroop test did not affect the subjects' cognitive performance.

The results contrast the Kenemans et al. (1999) study, which reported that caffeine significantly affected Stroop interference. Additionally, the current study's findings are consistent with Einöther et al. (2010) results, which found that caffeine and L-

theanine did not significantly affect subjective alertness or intersensory attention in healthy adults. However, Einöther et al. (2010) found that combining caffeine and L-theanine improved task switching, which differs from the Stroop test used in this study. In Scholey et al. (2000) study, administering an extract of Bacopa monniera (Brahmi) significantly improved cognitive function, while the present study found no significant differences in cognitive function among subjects who consumed decaf, caffeine, or taurine. Furthermore, the study by Childs et al. (2011) reported that caffeine and d-amphetamine improved performance on the Stroop task compared to placebo, contrasting with the present study's findings. Finally, compared to Giles et al. (2012), who investigated the differential cognitive effects of energy drink ingredients, the present study found no statistically significant effects of caffeine and taurine on cognitive function, as measured by the Stroop test. The results from Giles et al. (2012) showed that caffeine and taurine improved aspects of cognitive function, such as attention and processing speed, whereas glucose did not have a significant effect. Additionally, in contrast to the findings of Nešić et al. (2015), which reported that the combination of caffeine and taurine improved selective attention, the present study found no significant effects of caffeine or taurine on cognitive function, as measured by the Stroop test.

Despite the noteworthy findings of this study, several limitations need to be acknowledged. First, the sampling method used in this study was convenient, which may have resulted in a biased sample. A better sampling method, such as random sampling, would have resulted in a more representative sample. Moreover, the researchers collected the results in their own time and place, which may have introduced variations in the experimental conditions. To minimize these variations, a more standardized procedure could have been implemented. Finally, it should be noted that not all subjects were enthusiastic about participating in the study, which may have affected the overall motivation and performance of the participants. Future studies should address these limitations to increase the validity and reliability of their results.

CONCLUSION

The current study used a one-way ANOVA to examine the impact of caffeine and taurine on cognitive functions, particularly selective attention. The findings showed no statistically significant variations in cognitive performance amongst the three groups: caffeine, taurine, and decaf (control). As a result, the null hypothesis cannot be rejected.

Declaration by Authors

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REFERENCES

1. Babbie, E. (2016). *The practice of social research*. Cengage Learning.
2. British Psychological Society. (2018). *Code of human research ethics.* https://www.bps.org.uk/sites/www.bps.org.uk/files/Policy/Policy%20-%20Files/BPS%20Code%20of%20Human%20Research%20Ethics%204th%20Edition%202018.pdf
3. Chiaravalloti, N. D., Christodoulou, C., Demaree, H. A., & DeLuca, J. (2002). *Differentiating simple versus complex processing speed: Influence on new learning and memory performance.* Journal of the International Neuropsychological Society, 8(02), 182-190.
4. Childs, E., de Wit, H., & de la Garza, R. (2011*). Effects of acute caffeine, d-amphetamine, and placebo on the performance of the Stroop task by sleep-deprived subjects.* Experimental and Clinical Psychopharmacology, 19(4), 302-309.
5. Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches.* Sage publications.

6. Einöther, S. J., Martens, V. E., Rycroft, J. A., & De Bruin, E. A. (2010). *L-theanine and caffeine improve task switching but not intersensory attention or subjective alertness.* Appetite, 54(2), 406-409.
7. Field, A. (2018). *Discovering statistics using IBM SPSS statistics*. Sage.
8. Giles, G. E., Mahoney, C. R., Brunye, T. T., Gardony, A. L., Taylor, H. A., & Kanarek, R. B. (2012). *Differential cognitive effects of energy drink ingredients: caffeine, taurine, and glucose*. Pharmacology Biochemistry and Behavior, 102(4), 569-577.
9. Golden, C. J., & Freshwater, S. M. (2002). *Stroop color and word test: A manual for clinical and experimental uses.* Wood Dale, IL: Stoelting Co.
10. Kenemans, J. L., Wieleman, J. S., Zeegers, M., & Verbaten, M. N. (1999). *Caffeine and stroop interference.* Pharmacology Biochemistry and Behavior, 63(4), 589-598.
11. Kerns, J. G., Cohen, J. D., MacDonald, A. W., Cho, R. Y., Stenger, V. A., & Carter, C. S. (1999). *Anterior cingulate conflict monitoring and adjustments in control.* Science, 284(5411), 931-935.
12. Nešić, M., Lović, D., Mitić, J., & Stanković, M. (2015). *Effects of caffeine and taurine in combination with caffeine on selective attention.* Clinical Neurophysiology, 126(9), e183.
13. Pantic, I., Aarts, H., Custers, R., & Bekkering, H. (2014). *Action-effect binding induces cognitive conflict as well as facilitation.* Frontiers in psychology, 5, 401.
14. Scholey, A. B., Kennedy, D. O., & Wesnes, K. A. (2000). *The effects of an extract of Bacopa monniera (Brahmi) on cognitive function in healthy human subjects.* Psychopharmacology, 156(4), 481-484.
15. Stroop, J. R. (1935). *Studies of interference in serial verbal reactions.* Journal of experimental psychology, 18(6), 643.
16. Verhaeghen, P., & Cerella, J. (2002). *Aging, executive control, and attention: a review of meta-analyses.* Neuroscience & Biobehavioral Reviews, 26(7), 849-857.
17. Williams, J. M., Mathews, A., & MacLeod, C. (1996). *The emotional Stroop task and psychopathology.* Psychological bulletin, 120(1), 3-24.

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