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Black tea enhances cognitive function and improves short-term memory

Dinesh Vedanathan Syce (DV Syce)
Department of Physiology, Jawaharlal Institute of postgraduate education and research (JIPMER)Karaikal

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ABSTRACT
Background: Although there is an abundance of information on the effect of tea on psychomotor function, very few studies have determined if the consumption of tea can affect short-term memory. **Objectives**: The objectives of this study were to determine if black teahad any demonstrable effect on cognitive function and short-term memory. **Materials and methods**: The fifty participants who volunteered for this studywere required to complete a set of cognitive function tests such as letter cancellation and Digit symbol substitution test (DSST) and tests of short-term memory. They were then instructed to drink a cup of black tea. Fifteen minutes after they consumed the tea, the same tests were repeated.**Results**: After ingesting tea it was noticed that the time for letter cancellation and DSST was significantly shortened. There was a significant increase in the number of objects recalled ($p<0.004$) but no appreciable effect onimmediate wordrecall. **Conclusions**: This study demonstrates that tea enhances cognitive performance, significantly improves the immediate recall of objects but plays no role in the immediate recall of spoken words.
Keywords: **C**ognitive function, short-term memory

I. INTRODUCTION

Black teacontains several chemical compounds such as caffeine, catechinsand L-theanine [1].Although it has been well documented that ingestion of black tea can enhance psychomotor function, it is yet to be conclusively demonstrated if black tea has any effect on short-term memory. Some researchers are of the opinion that it does indeed improve short-term memory [2 - 4] while others assert that it has no effect on memory whatsoever [5].Furthermore, the effects of tea on tests of cognitive function such as digit symbol substitution test (DSST) and letter cancellation are yet to be demonstrated. The author endeavored to address these issues in the present study. The purpose of this study was to determine the effects of a cup of black tea on the afore-mentioned parameters in young south Indian subjects.

II. MATERIALS AND METHODS

Study design

This was an interventional study by design and was carried out over a nine month period between the years 2009 and 2010 in the Department of Physiology at PIMS, Pondicherry.Fifty participants volunteered for the study and were assigned to a single group.

Inclusion criteria

Males between18 and 25 years of age and those who consumed less than four cups of caffeinated drinks daily were included in this study..

Exclusion criteria

Those with systemic illnesses were excluded. The following individuals were also excluded – those who hadneuromuscular diseases and sleep disorders.

Ethical approval

Before the project began, clearance was obtained from the research and ethical committees of the institute. A written consent was obtained from each participant before the recordings commenced.

Procedure

The recordings were performed between 9 and 11 am in the research laboratory of the Department of Physiology. Anthropometric measurements were noted down and the following tests were then performed in the order mentioned below

Letter Cancellation

Twenty six jumbled letters of the English alphabet were printed on a piece of paper. The investigator read out tenrandom letters and the participant had to strike out the appropriate letter as quickly as he could. The time taken for the participant to strike out all ten letters was timed with a stop watch [6].

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Digit Symbol substitution test (DSST)

One hundred numbers, both even and odd, were presented to the subject on a chart paper. The subject had to draw an appropriate symbol over each digit , a circle for even numbers and a triangle for odd numbers. With the help of a stopwatch, the time taken by the participant to substitute the appropriate symbol for all the digits was noted [7].

Immediate Word recall

Twenty random words were read out by the investigator over a span of forty seconds. As soon as the investigator read out the words, the participant had to write downas many words as he could recall. He was given sixty seconds to complete this task.

Immediate Object recall

Twenty objects were placed on a table. The participant was allowed to look at the objects for a period of fifteen seconds. The objects were then hidden from sight and the participant had to write down as many objects as he could remember within the given time of sixty seconds .

After these baseline recordings, the participant was told to drink a cup of tea. The tea for this study was made as explained below. One tea bag (TajMahal) was placed in a cup of hot water for exactly three minutes. Ten grams of sugar (weighed on a scientific balance) was also added. Before the tea bag was removed from the cup it was thoroughly squeezed[8]. The tea was then cooled down to a temperature of 55°C (measured with a mercury thermometer). The participant was then told to drink the entire quantity of the prepared beverage within two minutes.The same tests were repeated 15 minutes after ingesting tea.

III. STATISTICAL ANALYSIS

Student's paired 't' test was utilized to analyze all the variables recorded in this study.

IV. RESULTS

The fifty participants had a mean height of 1.66 ± 0.25 meters , a mean weight of 63.66 ± 11.66 Kilograms and a mean BMI of 22.9 ± 4.2 Kg/m^2 . After drinking tea there was observed a shortening of the time taken by the subjects for letter cancellation and Digit SymbolSubstitution . These results were found to be statistically significant ($p<0.001$) and are detailed in Table 1. It was noticed that after drinking tea there was a significant increase in the number of objects recalled ($p<0.004$) but no change ($p=0.592$) in the number of words were recalled(Table 1).

V. DISCUSSION

Although letter cancellation and Digit Symbol Substitution Test (DSST)are simple and sensitive cognitive function tests, very few studies, if any at all, have investigated the effect of tea on these parameters. Letter cancellation is apencil and paper test widely used in clinical settingsas a quick measure of concentration and cognitive ability.The speed at which the subject cancels letters as soon as they are called out may be influenced by factors such as age [9] and language [10].Digit Symbol Substitution Test (DSST) is a cognitive function test that involves substituting an appropriate symbol for a number. The time taken for DSST is influenced by the age of the subject [11,12], level of education [7], alcohol intake [13] and diseases such as diabetes [14]. In the present study it was noticed that a few minutes after ingesting a cup of tea, there was a significant shortening in the time taken for letter cancellation and digit symbol substitution, indicative of an improvement in cognitive performance.Research has demonstrated that caffeine, a chemical compound present in tea exerts a modulatory effect on brain function and may be responsible for the improvement in cognitive function observed after consuming tea. It has been suggested thatCaffeine, exerts its actions by blocking A_1 adenosine receptorsin the hippocampus and cerebral cortex [15,16],by blocking A_{2a} adenosinereceptors inthe nucleus accumbens [17], by increasing metabolism in the reticular formation [18]and even by stimulating cortical electrical activity [19,20].Studies which investigated the effects of tea orof caffeine alone on other tests of cognitive function have reported resultscomparable to the present study. Studies on the effects of black tea on psychomotor and cognitive function concluded thattea consumption resulted in a rapid improvement in the level of alertness [21,22]. It was observed that tea, if consumed repeatedly over the day, could improve cognitive performance and produce a level of alertness comparable to that of coffee [23].Other studies have sought to determine the effect of L-theanine (a constituent of tea) on cognitive function. These studiesdemonstrated that ingestion of L-theanine alone decreased the levels of alertness and had no appreciable effect on cognitive function [4].The reason for this could be the state of relaxation that theanine is known to produce in human subjects [24].

Very few studies have investigated the effect of tea on memory. Studies on the effect of

caffeine, a constituent of tea, on short-term memory are at best inconclusive. Some researchers are of the opinion that ingestion of caffeine improves the performance on immediate recall tasks [25-28]. However, most studies have demonstrated that caffeine had either no effect on recall performance [29-32] or actually impaired short-term memory [33].This lack of clarity is probably due to the amount of caffeine administered, the time of consumption and the recall tasks employed. The present study limited itself to the effect of a cup of black tea on the immediate recall of words and objects.It was observed that a significantly higher number of objects were recalled after tea. There was however no significant increase in the number of words recalled.This improvement in short-term memory can probably be explained by the knowledge that caffeine acts on parts of the brain concerned with short-term memory.Researchers have demonstrated that the left prefrontal cortex is involved in encoding short-term memory [34] and theright anterior prefrontal area plays a role in the immediate recall of words and pictures [35].Caffeine has been demonstrated to increase activity in the medial frontopolar cortex[36]. Studies have demonstrated that the hippocampusmay also play a role in working memory [37], hence caffeine which is known to block hippocampal A_1 receptors [15] may actually be able to improve short-term memory. These are possible explanations for the improvement in short-term memory observed in the present study.

VI. CONCLUSIONS

At the end of this nine month study the conclusions reached were that tea improvescognitive performance, significantly improves theimmediate recall of objects but plays no role in the immediate recall of spoken words.In the present study the author sought to investigate the effects of a cup of tea, the sort millions consume every day, on cognitive performance. This study involved fifty subjects who were all required to ingest black tea. The author is of the view that a placebo- controlled approach would have been more scientific

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Parameter	Before tea n = 50	After tea n = 50	p value
Letter cancellation (s)	25.68 ± 5.73	22 ± 5	<0.001
DSST (s)	108.44 ± 27.43	92 ± 21	<0.001
Immediate word recall	9.54 ± 2.61	9.7 ± 3.1	0.592
Immediate object recall	11.24±2.75	12 ± 2.7	0.004

Table 1 Effect of tea on tests of cognitive function and short-term memeory

All data are expressed as Mean ± standard deviation. Letter cancellation is expressed as the time in seconds taken to cancel 10 letters. DSST (digit symbol substitution) is expressed as the time taken in seconds to substitute an appropriate symbol for 100 digits. Immediate word and immediate object recall are expressed as the number of words or objects recalled in one minute.