

## RESEARCH ARTICLE

# Evaluation of impact of lunch on cognition in healthy working individuals using Stroop test

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### ABSTRACT

**Background:** Cognition refers to the mental processes involved in gaining knowledge and comprehension. It represents a complex, multidimensional set of abilities. Various factors affect cognitive performance with meals being one of the important one. **Aim and Objective:** This study was aimed to evaluate the pre-lunch and post-lunch cognition levels in healthy working individuals using Stroop test. **Materials and Methods:** Eighty healthy individuals of either sex in the age range 18–60 years were recruited. The study had a quasi-experimental before-after design. All the study participants were screened for cognitive impairment using mini-mental state examination. Those without any cognitive impairment were administered Stroop test (congruent and incongruent) before and after consumption of afternoon meals which was presumably of mixed nature. Paired t-test was used for analyzing the acquired data with significance set to “5%.” **Results:** A statistically significant reduction in time taken to complete the test and increment in number of correct responses under both conditions (congruent and incongruent) of Stroop test was seen after consumption of afternoon meals. **Conclusion:** It can be reasonably deduced from the observations of this study that cognitive performance, especially executive functioning as evaluated by Stroop test, improves following consumption of lunch. Therefore, proper lunch in terms of size and composition should be consumed by working individuals to facilitate their work output.

**KEY WORDS:** Cognition; Comprehension; Meals; Stroop Test


**ABBREVIATIONS:** MMSE – Mini-mental state examination; SCWT – Stroop color and word test

### INTRODUCTION

Cognition refers to “any form of information processing, mental operation, or intellectual activity such as thinking, reasoning, remembering, imagining, or learning.”<sup>[1]</sup>

Cognition encompasses wide array of abilities. It includes processes such as human perception, attention, learning, memory, concept formation, reasoning, judgment and decision-making, problem-solving, and language processing.<sup>[2]</sup>

Reasoning (mechanical, verbal, numerical, and spatial) is one among many components of cognition. Memory, reasoning, attention, and psychomotor coordination are only a few of the functions that contribute to mental ability. Memory itself is a very complex set of processes (e.g., short term, long term, visual, spatial, verbal, declarative, semantic, and strategic) that can be investigated using different assessment tools.<sup>[3]</sup> Assessment of

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cognitive function is a challenging yet an integral component of psychological, psychiatric, and neurological evaluation.<sup>[4]</sup>

A host of factors which affect cognitive functioning have been identified. This includes age, education period, gender, lifestyle factors such as alcohol drinking and smoking, depression, social factors such as social activity and occupation, history of disease, and body mass index, and many other factors.<sup>[5]</sup>

One of the important factors affecting cognition level in healthy individual is the intake of meals. Postprandial glucose levels are known to be substantially affected by diet and components of diet such as carbohydrates and protein. It is well established that poor nutrition, particularly early in life, can have lasting effects on brain functioning and cognitive performance. In contrast, much less is known about the short-term effects of meals on cognitive behavior in well-nourished individuals. Interest in this area of research has primarily stemmed from the desire to improve cognitive performance in either the workplace or classroom.<sup>[5]</sup>

Cognition tests are form of psychometric and neuropsychological assessment designed to measure general intelligence. Typically, cognition ability tests cover following categories – numerical, verbal, spatial, and mechanical reasoning. Various cognition tests are assessed to check the cognition capability of an individual. There are various simple tests to assess cognition levels such as intelligence quotient test, General Practitioner Assessment of Cognition/MCOG test, clock test, trail making test, Stroop test, and Stanford–Binet intelligence scale.<sup>[5]</sup>

The Stroop Color and Word Test (SCWT) is a neuropsychological test extensively used to assess the ability to inhibit cognitive interference that occurs when the processing of a specific stimulus feature impedes the simultaneous processing of a second stimulus attribute, well-known as the Stroop effect. While the SCWT is widely used to measure the ability to inhibit cognitive interference; previous literature also reports its application to measure other cognitive functions such as attention, processing speed, cognitive flexibility, and working memory. Thus, it may be possible to use the SCWT to measure multiple cognitive functions.<sup>[6]</sup>

Different studies have analyzed the effect of lunch on cognition. However, there is a paucity of literature defining the exact role of afternoon meals on different aspects of cognition. Some have found meals to be a facilitator of cognitive tasks, whereas others have reported a post-lunch dip on certain components of cognition.

The present study was conducted to assess the effect of lunch (composed of normal mixed diet) on cognition in healthy individuals using Stroop test. This study was designed keeping in mind the general middle-class working population in India working at their work places from 9 am to 5 pm.

## AIMS AND OBJECTIVES

- The primary objective of the study was to evaluate the pre-lunch and post-lunch cognition level in healthy working individuals.
- Cognitive attributes which have a direct impact on the work output of the individual such as attention, processing speed, working memory, and executive processes were explored using Stroop test.

## MATERIALS AND METHODS

The study included 80 healthy individuals who were randomly selected from the list of full-time employees at Kalpana Chawla Medical College, Karnal (Haryana). The study had a quasi-experimental before-after design.

### Inclusion Criteria

The following criteria were included in the study:

- Age 18–60 years
- Minimum education level Class V (formal schooling)
- Full-time employees of KCGMC, Karnal
- Having proper lunch routine during lunch break, that is, 1 pm–2 pm
- Having mixed normal diet and following their daily routine such as smoking, tea, and coffee
- MMSE score  $\geq 25$ .

### Exclusion Criteria

The following criteria were excluded from the study:

- <18–>60 years
- Uneducated
- Do not have proper lunch
- MMSE score <25
- Any chronic illness, childhood attention disorders
- Epilepsy, hypertension
- History of head injury
- Central nervous system pathology.

### Methodology

The subjects fitting in inclusion criteria were selected. Informed consent form and participant information sheet were duly signed by them. The study protocol was duly approved by the Institutional Ethics Committee.

Pre-lunch testing was done between 12:00 noon and 1:00 pm, just before the official lunch hour, that is, 1 pm and 2 pm. The subjects ate lunch which they regularly bring or eat during lunch hours. They were allowed to follow their daily routine such as having tea, coffee, or smoke during pre-lunch or post-lunch hours or in between. Post-lunch testing was done after 1–1 ½ h of their meals, that is, between 2 pm and 3 pm in the afternoon.

**Cognitive Testing**

Cognitive testing was carried out using simple paper and pencil tests on eligible participants.

Mini-mental state examination was done to assess the general cognition levels of the individual. Those who scored <25 were excluded from the study and those who scored ≥25 on MMSE test were administered congruent (C) and incongruent (CW) Stroop test.

In both the tests, no. of correct responses (out of 40) and time taken to complete the test were noted. These cognition tests were administered one after the another of increasing difficulty and the results were recorded.

**Statistical Analysis**

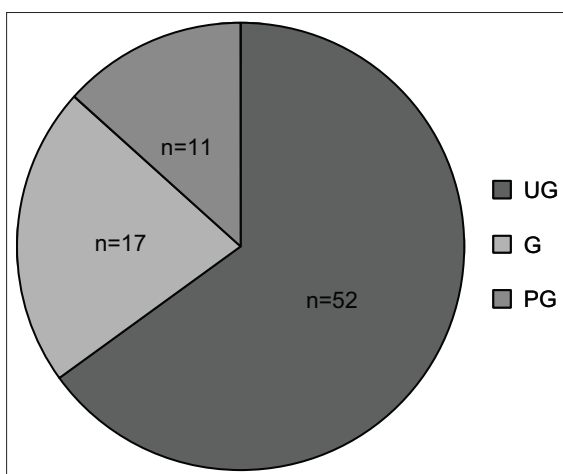
SPSS software version 20.0 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis. Observed values were expressed in terms of mean and standard deviation. Significance of the difference between pre-lunch and post-lunch values was tested using Student’s (paired) t-test with significance level set at “5%.”

**RESULTS**

The study was conducted at the Department of Physiology, Kalpana Chawla Medical College, Karnal, Haryana (India), from July 2018 to September 2018. Demographic

**Table 1:** Distribution of the study participants based on age and gender (Total=80)

Variable	Age (years)		Gender	
	18–30	31–60	Males	Females
Number of subjects (n)	39	41	40	40

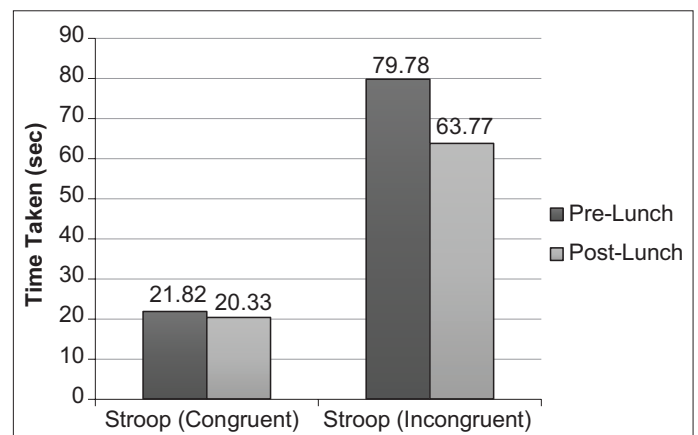


**Figure 1:** Distribution of subjects as per educational level. \*UG: Undergraduate, G: Graduate, PG: Postgraduate

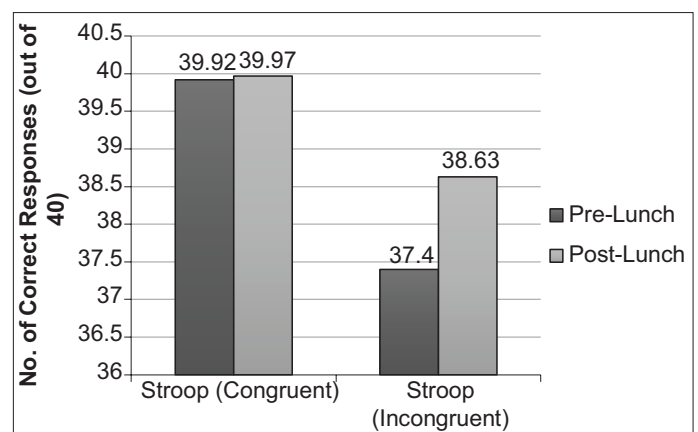
characteristics of the study participants are shown in Table 1. Figure 1 shows how the study subjects are distributed as per their educational status. A maximum number of study participants were undergraduates. Figure 2 illustrates the difference in time taken for completing Stroop test (congruent and incongruent) before and after having afternoon meals. A statistically significant ( $P < 0.05$ ) dip in post-lunch time values was seen for both the conditions (congruent and incongruent). Increment in number of correct responses was also observed after consumption of lunch under both the conditions [Figure 3].

**DISCUSSION**

Our study performed on 80 healthy working individuals (40 males and 40 females) in age range 18–60 years showed an enhancement in cognition levels, especially attention, processing speed, executive processes, and working memory after consumption of lunch which was of mixed nature (macronutrients). A definitive improvement in terms of time taken to finish the task (Stroop test) as well as accuracy [Figures 2 and 3] was seen post-lunch.



**Figure 2:** Comparison of pre-lunch and post-lunch time taken for Stroop test (congruent and incongruent)



**Figure 3:** Comparison of accuracy (number of correct responses out of 40) for Stroop test (congruent and incongruent) before and after taking lunch

Our results are in corroboration with some studies which have shown similar findings. Some studies have shown improvement after consumption of afternoon meals. In one study, subjects with higher glucose tolerance showed improved performance on cognitive tests ( $P < 0.05$ ). They performed better in the working memory test at 90 min ( $P < 0.05$ ) and after the simulated low glycemic index (GI) breakfast compared with the simulated high GI breakfast. Possibly, the cognitive functions might be enhanced by avoiding a sharp decline in blood glucose concentration and by maintaining a higher glycemia in the late postprandial period.<sup>[7]</sup> Kanarek (1997) and Kanarek and Swinney (1990) have suggested that intake of carbohydrate-rich snack in the afternoon can improve cognitive performance in the adults.<sup>[8,9]</sup> Schroder *et al.* (2015) have indicated that lunch intake is beneficial for updating the working memory which may be due to increased cortisol levels post-lunch.<sup>[10]</sup>

Many of the recorded literature sources, however, have reported that there is a dip in post-lunch cognition levels. Craig *et al.* (1981) examined the lunch affected the efficiency of perceptual discrimination. This measure was chosen because of the significance to many work-related tasks. Participants performed this task before and after eating a three-course lunch and/or having no lunch. The authors concluded that consumption of lunch is an important precursor for the post-lunch dip in performance.<sup>[11]</sup>

Although there is not a clear consensus of how mixed meals affect performance, several mechanisms have been considered, including increase in the level of blood glucose and individual effects of macronutrients on neurotransmitter synthesis. Brain is sensitive to metabolic changes associated with pattern of meals and fasting and also long-term nutritional status, glucose being the main fuel of the brain. Morning (breakfast), afternoon (lunch), and evening (dinner) meals regulate the glycemic levels in our blood and have a gross impact on the neuronal functioning and memory circuits.<sup>[12]</sup> The neuroplasticity mechanisms underlying cognitive and behavioral alterations, particularly neuronal alterations in hippocampus and pre-frontal cortex, are essential for encoding memories and controlling our behavior.<sup>[13]</sup>

Beneton (1996) has stressed the importance of neurotransmitters such as noradrenaline, acetylcholine, and serotonin which are also dependent on glucose metabolism, are essential for fine motor skills and cognitive processes. Poor diet is a potential risk factor for the development of cognitive impairment; conversely dietary nutrients are protective against such impairments.<sup>[14]</sup> On the other hand, excessive consumption of certain dietary components is associated with reduced global cognitive function, cognitive decline, and dementia. Studies have revealed that high-protein meals lead to increased distractibility, whereas high carbohydrate meals lead to slowing of reactions times.<sup>[15]</sup>

Endogenous biological rhythms may also have an effect on cognition after meals.<sup>[16]</sup> Individuals tend to be more alert in the early part of the day and may suffer from a decreased alertness and efficiency around 2 pm.<sup>[17]</sup> Similarly, studies conducted in the laboratory have found that a drop in performance of mental tasks often is reported approximately 1 h after consuming lunch and may take several hours to return to the pre-lunch state.<sup>[18,19]</sup> Some studies indicate that mental abilities at midday are impaired to a greater degree in individuals who have consumed lunch than in those who have not, indicating that food intake does contribute to the post-lunch dip.<sup>[11,18,19]</sup>

Although it is hard to determine how macronutrients affect performance when studied in mixed meals rather than tests of single nutrients, mixed-meal studies are valuable in that these represent the way people normally eat.

Improvement in post-lunch cognition in our study might be due to the consumption of mixed meal rich in carbohydrates (provided by chapattis, rice, potatoes, etc.) by the participants. Glycemic levels in the blood may be more stabilized after consuming such diet. Furthermore, participants were allowed to follow their normal routine before and after lunch such as drinking tea, coffee, and smoking. Improvement might also be due to repeated testing on subjective tests like Stroop.

### Limitations of the Study

Before concluding, few possible limitations of the study should be acknowledged. There was no proper control group in the study. Subjects were tested before and after being exposed to the intervention (lunch). Lunch size and composition which are known to affect cognition were not kept fixed. Only limited cognitive domains as assessed by Stroop test were evaluated.

To further support the findings of our study, large-scale population-based studies taking into account different demographic parameters and controlling the different confounders should be designed.

### CONCLUSION

Our study analyzing the effect of afternoon meals (during lunch hours) on cognition in general Indian working population revealed significant improvement in the attention, processing speed, working memory, and executive functioning of the brain as deciphered by improved performance seen during administered Stroop test. Based on the observations of this study, we can hypothesize that consumption of lunch may facilitate working efficiency at designated work places.

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