Summary

The present study derived the origin from Smith and Kendrick (1992) and Kanarek’s (1997) suggestions in regard to the role of meal intake on cognitive performance. Only a few studies have been conducted in this area, and these have been devoted to investigate the separate influence of only three variables namely gender, meal and some of the personality dimensions. Not even a single study, more specifically even in Indian context has been conducted so far where the relationship of temperamental dimensions (emotionality, activity, sociability and impulsivity), lunch conditions (skipping of lunch, snacks in lunch and proper lunch) and gender (male and female) have been investigated altogether on cognitive performance. The present study has a step in this direction.

Objectives

The main objectives of the present study were –

1. To study the independent effect of temperamental dimensions (i.e. emotionality, activity, sociability and impulsivity) on cognitive performance.
4. To study the independent effect of lunch conditions (varied at three levels i.e. skipping of lunch, snacks only in lunch and proper vegetarian lunch) on cognitive performance.
5. To study the gender differences in cognitive performance.
6. To study the interactive effects of temperamental dimensions, lunch conditions and gender on cognitive performance.

Hypotheses

1. Low scorers on all temperamental dimensions will perform better on cognitive performance tasks than the high scorers.
2. Post-lunch dip in cognitive performance will be the greatest with proper vegetarian lunch as compared to no lunch and snacks in lunch (light lunch).
1. There will be significant gender differences in cognitive performance.
   a) Females will perform better than males on stroop test performance.
   b) Males will outperform females on visual search test and digit span test.
Sample

For preliminary testing, a stratified random sample of 400 undergraduate and post graduate subjects (200 males and 200 females) from various universities of Delhi in the age group of (17-25) years was drawn for the present study.

EASI- III Temperamental Survey (Buss and Plomin, 1975) was administered to all the subjects and the subjects were categorized into ‘high scorers’ and ‘low scorers’ on the basis of dependent of Mean ± 0.44 S.D (33 % of subjects) on each temperamental dimension.

The score ranges of male subjects in each two groups (high and low) were:

<table>
<thead>
<tr>
<th>Temperamental Dimension</th>
<th>Score Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotionality</td>
<td>High Scorers 44 and above</td>
</tr>
<tr>
<td></td>
<td>Low Scorers 37 and below</td>
</tr>
<tr>
<td>Activity</td>
<td>High Scorers 35 and above</td>
</tr>
<tr>
<td></td>
<td>Low Scorers 30 and below</td>
</tr>
<tr>
<td>Sociability</td>
<td>High Scorers 19 and above</td>
</tr>
<tr>
<td></td>
<td>Low Scorers 15 and below</td>
</tr>
<tr>
<td>Impulsivity</td>
<td>High Scorers 59 and above</td>
</tr>
<tr>
<td></td>
<td>Low Scorers 52 and below</td>
</tr>
</tbody>
</table>

The score ranges of female subjects in each of the two groups (high and low) were:

<table>
<thead>
<tr>
<th>Temperamental Dimension</th>
<th>Score Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emotionality</td>
<td>High Scorers 48 and above</td>
</tr>
<tr>
<td></td>
<td>Low Scorers 42 and below</td>
</tr>
<tr>
<td>Activity</td>
<td>High Scorers 37 and above</td>
</tr>
<tr>
<td></td>
<td>Low Scorers 31 and below</td>
</tr>
<tr>
<td>Sociability</td>
<td>High Scorers 18 and above</td>
</tr>
<tr>
<td>Impulsivity Temperament</td>
<td>Score Range</td>
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<td>------------------------</td>
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</tr>
<tr>
<td>High Scorers</td>
<td>58 and above</td>
</tr>
<tr>
<td>Low Scorers</td>
<td>52 and below</td>
</tr>
</tbody>
</table>

Each of these groups was further randomly assigned to three lunch conditions namely proper lunch, snacks in lunch and no lunch. Each group consisted of 10 subjects. Therefore, there are 120 subjects in all for each experiment.

**Tools**

Following tests were used for the present study:

1. EASI-III Temperamental Survey: (Buss and Plomin, 1975), which provides scores on four temperamental dimensions namely emotionality, activity, sociability and impulsivity.
2. Computerized version of Stroop Test: (Cog Lab on a CD by Francis and Neath, 2004), which provides scores on name and font same and name and font different.
3. Computerized version of Visual Search Test: (Cog Lab on a CD by Francis and Neath, 2004)
4. Digit Span Test: Wechsler Adult Intelligence Scale (Wechsler, 1955)

**Design**

The present study involved three independent variables namely temperamental dimensions, lunch conditions and gender. The present study consisted of 16 independent experiments. A $2 \times 3 \times 2$ factorial design involving two levels of each temperamental dimension (high and low), three conditions of food intake (skipping of lunch, snacks in lunch and proper vegetarian lunch) and two levels of gender (male and female) was used in each experiment for investigating the independent and interactive effects of the independent variables on each of four dependent variables i.e. cognitive tasks namely stroop test (name and font same), stroop test (name and font different), visual search test and digit span test. One replication of the design needed 12 ($2 \times 3 \times 2$) subjects. The design was replicated 10 times. Hence, there were 120 ($12 \times 10$) subjects in each of the 16 experiments specified above. In addition, correlated t-test was applied to check the significance of differences between the means involved in pre-lunch and post-lunch conditions for all the groups in all the experiments. A correlated t-test was also applied in order to see the significance of differences in mean scores on stroop test (name and font same) and on mean scores on stroop test (name and font different) in all experiments.
Procedure

All the 400 subjects (200 males and 200 females) were initially administered EASI-III Temperament Survey. On the basis of their scores, subjects were categorized into two extreme groups; high and low scorers, on the basis of criterion of mean ± 0.44 S.D. (33% of subjects in each group) on each temperamental dimension. These subjects were further randomly assigned to three lunch conditions namely skipping of lunch, snacks in lunch and proper vegetarian lunch. Each group consisted of 10 subjects. The snack in lunch consisted of a sandwich and 2 biscuits and proper vegetarian lunch consisted of a thali having 2-3 chapatis, 1 bowl of rice, 1 bowl of dal, 1 bowl of seasonal vegetables and 1 bowl of curd. The subjects participating in the experiment were given a free lunch (the subjects who were in the skipped lunch condition were given their free meal after testing was completed). The subjects were administered cognitive tasks twice [one hour before (between 12:00 to 01:00 P. M.) and one hour after the lunch (between 02:00 to 3:00 P. M.)]. To avoid the boredom factor, subjects were given 5 min. to rest after each task. Pre and Post lunch scores were noted down for each subject and their differences were calculated.

Results

The differences (post-pre) between post-lunch and pre-lunch scores for all the dependent measures for all the groups were used for data analysis.

Before, the data analysis, for all dependent measures were subjected to $2 \times 3 \times 2$ three-way analysis of variance, these were tested for the assumption of homogeneity of variance by Cochran test. Whenever the two way and three way interactions were found to be statistically significant, the significance of differences among means involved in such interactions were further tested by Duncan’s Multiple Range Test. The results of present study summarized as follows:
I. Emotionality (A) × Lunch Conditions (B) × Gender (C):

(a) Stroop Test (name and font same)

**Significant Main Effects**

1. **Emotionality** produced a significant \( p < 0.01 \) impact on stroop test performance. Low emotional subjects performed better than high emotional subjects.

2. **Lunch conditions** significantly \( p < 0.01 \) impacted on stroop test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch conditions (snacks only).

3. **Gender** also produced significant effect \( p < 0.01 \) on stroop test performance i.e. females performed better than males.

**Significant Interactions**

1. **Emotionality × Lunch Conditions** \( p < 0.01 \)

2. **Lunch Conditions × Gender** \( p < 0.01 \)

3. **Emotionality × Lunch Conditions × Gender** \( p < 0.01 \)

(b) Stroop Test (name and font different)

**Significant Main Effects**

1. **Emotionality** produced a significant \( p < 0.01 \) impact on stroop test performance. Low emotional subjects performed better than high emotional subjects.

2. **Lunch conditions** significantly \( p < 0.01 \) impacted on stroop test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch conditions (snacks only).

3. **Gender** also produced significant effect \( p < 0.01 \) on stroop test performance i.e. females performed better than males.

**Significant Interactions**

1. **Emotionality × Lunch Condition** \( p < 0.01 \)

2. **Lunch Conditions × Gender** \( p < 0.01 \)

3. **Emotionality × Gender** \( p < 0.01 \)

4. **Emotionality × Lunch Conditions × Gender** \( p < 0.01 \)
(c) **Visual Search Test:**

**Significant Main Effects**

1. **Emotionality** produced a significant ($p < 0.01$) impact on visual search test performance. Low emotional subjects performed better than high emotional subjects.

2. **Lunch conditions** significantly ($p < 0.01$) impacted on visual search test performance. Post lunch dip was greatest when subjects had proper vegetarian lunch than no lunch and light lunch conditions (snacks only).

3. **Gender** also produced a significant effect ($p < 0.01$) on visual search test performance i.e. females performed better than males.

**Significant Interactions**

1. **Emotionality × Lunch Conditions ($p < 0.01$)**

2. **Lunch Conditions × Gender ($p < 0.01$)**

(d) **Digit Span Test:**

**Significant Main Effects**

1. **Emotionality** produced a significant ($p < 0.05$) impact on digit span test performance. Low emotional subjects performed better than high emotional subjects.

2. **Lunch conditions** significantly ($p < 0.01$) impacted on digit span test performance. Post lunch dip was greatest when subjects had proper vegetarian lunch than no lunch and light lunch conditions (snacks only).

3. **Gender** also produced a significant effect ($p < 0.01$) on digit span test performance i.e. males performed better than females.

II. **Activity (A) × Lunch Conditions (B) × Gender (C):**

(a) **Stroop Test (name and font same)**

**Significant Main Effects**

1. **Activity** produced a significant ($p < 0.01$) impact on stroop test performance. Low active subjects performed better than high active subjects.
2. **Lunch conditions** significantly \((p< 0.01)\) impacted on stroop test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch conditions (snacks only).

3. **Gender** also produced a significant effect \((p< 0.01)\) on stroop test performance i.e. females performed better than males.

**Significant Interactions**

1. **Activity × Lunch Conditions** \((p<0.01)\)
2. **Lunch Conditions × Gender** \((p<0.01)\)
3. **Activity × Lunch Conditions × Gender** \((p<0.05)\)

(b) **Stroop Test (name and font different)**

**Significant Main Effects**

1. **Activity** produced a significant \((p< 0.01)\) impact on stroop test performance. Low active subjects performed better than high active subjects.

2. **Lunch conditions** significantly \((p< 0.01)\) impacted on stroop test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch conditions (snacks only).

3. **Gender** also produced a significant effect \((p< 0.01)\) on stroop test performance i.e. females performed better than males.

**Significant Interactions**

1. **Activity × Lunch Conditions** \((p<0.01)\)
2. **Lunch Conditions × Gender** \((p<0.01)\)
3. **Activity × Lunch Conditions × Gender** \((p<0.01)\)

(c) **Visual Search Test:**

**Significant Main Effects**

1. **Activity** produced a significant \((p< 0.01)\) impact on visual search test performance. Low active subjects performed better than high active subjects.

2. **Lunch conditions** significantly \((p< 0.01)\) impacted on visual search test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch conditions (snacks only).
3. **Gender** also produced a significant effect (p< 0.01) on visual search test performance i.e. females performed better than males.

**Significant Interactions**

1. Activity × Lunch Conditions (p<0.01)
2. Lunch Conditions × Gender (p<0.01)

**d) Digit Span Test:**

**Significant Main Effects**

1. **Activity** produced a significant (p< 0.05) impact on digit span test performance. Low active subjects performed better than high active subjects.
2. **Lunch conditions** significantly (p< 0.01) impacted on digit span test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch conditions (snacks only).

**III. Sociability (A) × Lunch Conditions (B) × Gender (C):**

(a) **Stroop Test (name and font same)**

**Significant Main Effects**

1. **Sociability** produced a significant (p< 0.01) impact on stroop test performance. Low sociable subjects performed better than high sociable subjects.
2. **Lunch conditions** significantly (p< 0.01) impacted on stroop test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch (snacks only).
3. **Gender** also produced a significant effect (p< 0.01) on stroop test performance i.e. females performed better than males.

**Significant Interactions**

1. Sociability × Lunch Conditions (p<0.01)
2. Lunch Conditions × Gender (p<0.01)
3. Sociability × Lunch Conditions × Gender (p<0.05)
(b) **Stroop Test (name and font different)**

**Significant Main Effects**
1. **Sociability** produced a significant (p< 0.01) impact on stroop test performance. Low sociable subjects performed better than high sociable subjects.
2. **Lunch conditions** significantly (p< 0.01) impacted on stroop test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch conditions (snacks only).
3. **Gender** also produced a significant effect (p< 0.01) on stroop test performance i.e. females performed better than males.

**Significant Interactions**
1. **Sociability × Lunch Conditions** (p<0.01)
2. **Lunch Conditions × Gender** (p<0.01)
3. **Sociability × Gender** (p<0.01)
4. **Sociability × Lunch Conditions × Gender** (p<0.01)

(c) **Visual Search Test:**

**Significant Main Effects**
1. **Sociability** produced a significant (p< 0.01) impact on visual search test performance. Low sociable subjects performed better than high sociable subjects.
2. **Lunch conditions** significantly (p< 0.01) impacted on visual search test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch conditions (snacks only).
3. **Gender** also produced a significant effect (p< 0.01) on visual search test performance i.e. females performed better than males.

**Significant Interactions**
1. **Sociability × Lunch Conditions** (p<0.01)
2. **Lunch Conditions × Gender** (p<0.01)
(d) Digit Span Test:

**Significant Main Effects**

1. **Lunch conditions** significantly \( p < 0.01 \) impacted on digit span test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch (snacks only).
2. **Gender** also produced a significant effect \( p < 0.05 \) on digit span test performance i.e. males performed better than females.

IV. Impulsivity (A) \( \times \) Lunch Conditions (B) \( \times \) Gender (C):

(a) Stroop Test (name and font same)

**Significant Main Effects**

1. **Impulsivity** produced a significant \( p < 0.01 \) impact on stroop test performance. Low impulsive subjects performed better than high impulsive subjects.
2. **Lunch conditions** significantly \( p < 0.01 \) impacted on stroop test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch (snacks only).
3. **Gender** also produced a significant effect \( p < 0.01 \) on stroop test performance i.e. females performed better than males.

**Significant Interactions**

1. **Impulsivity \( \times \) Lunch Conditions**(p<0.01)
2. **Lunch Conditions \( \times \) Gender**(p<0.01)

(b) Stroop Test (name and font different)

**Significant Main Effects**

1. **Impulsivity** produced a significant \( p < 0.01 \) impact on stroop test performance. Low impulsive subjects performed better than high impulsive subjects.
2. **Lunch conditions** significantly \( p < 0.01 \) impacted on stroop test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch conditions (snacks only).
3. **Gender** also produced a significant effect (p< 0.01) on stroop test performance i.e. females performed better than males.

**Significant Interactions**

1. Impulsivity × Lunch Conditions (p<0.01)
2. Lunch Conditions × Gender (p<0.01)
3. Impulsivity × Gender (p<0.01)
4. Impulsivity × Lunch Conditions × Gender (p<0.01)

(c) **Visual Search Test:**

**Significant Main Effects**

1. **Impulsivity** produced a significant (p< 0.01) impact on visual search test performance. Low impulsive subjects performed better than high impulsive subjects.
2. **Lunch conditions** significantly (p< 0.01) impacted on visual search test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch conditions (snacks only).
3. **Gender** also produced a significant effect (p< 0.01) on visual search test performance i.e. females performed better than males.

**Significant Interactions**

1. Impulsivity × Lunch Conditions (p<0.01)
2. Lunch Conditions × Gender (p<0.01)
3. Impulsivity × Gender (p<0.05)
4. Impulsivity × Lunch Conditions × Gender (p<0.01)

(d) **Digit Span Test:**

**Significant Main Effects**

1. **Impulsivity** produced a significant (p< 0.05) impact on digit span test performance. Low impulsive subjects performed better than high impulsive subjects.
2. **Lunch conditions** significantly (p< 0.01) impacted on digit span test performance. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch and light lunch conditions (snacks only).
3. **Gender** also produced a significant effect (p< 0.05) on digit span test performance i.e. males performed better than females.
Abridged and Conclusive Findings

The main findings of the present study in respect of main effects and interactive effects are grouped under two sub-heads are as follows:

I. Main effects

1. Temperamental Dimensions
   The temperamental dimensions of emotionality, activity and impulsivity produced a significant effect on all dependent measures i.e. stroop test (name and font same), stroop test (name and font different), visual search test and digit span test. Low scorers on emotionality, activity and impulsivity performed better than high scorers on all cognitive tasks.

   Sociability dimension of temperament significantly impacted stroop test (name and font same), stroop test (name and font different) and visual search test performance but did not produce a significant effect on digit span test. Low scorers on sociability performed better than high scorers on stroop test (name and font same), stroop test (name and font different) and visual search test but low scorers of sociability did not differ from high scorers on digit span test performance.

2. Lunch Conditions
   The lunch conditions had a robust effect (results significant for all the groups) on all the cognitive tasks. Post lunch dip was the greatest when subjects had proper vegetarian lunch than no lunch (skipping of lunch) and light lunch conditions (snacks only). Subjects who skipped their lunch performed the best on all dependent variables.

3. Gender
   Gender also produced a significant effect on all dependent variables. The results very clearly indicate that females performed better than the males on three dependent measures i.e. stroop test (name and font same), stroop test (name and font different) and visual search test. Males performed better than females on digit span test.
II. Interactive Effects

The main findings of significant interactions are:

1. **A × B Interaction:**

   High emotional, high active, high sociable and high impulsive subjects who had proper lunch significantly had larger scores on stroop test (name and font same), stroop test (name and font different) and visual search test than those who had no lunch and those who had snacks in lunch. Low emotional/active/sociable/impulsive subjects who skipped their lunch performed better than those who had snacks in lunch and those who had proper lunch in all the groups.

2. **B × C Interaction:**

   For temperamentaldimensions namely emotionality, activity, sociability, impulsivitymales who had proper lunch significantly showed worst performance on stroop test (name and font same), stroop test (name and font different) and visual search test than those who had snacks in lunch and those who had no lunch. Similar differences were found in females in all the above groups. Females with no lunch performed the best in all the groups.

3. **A × C Interactions:**

   High emotional/sociable males significantly showed longer reaction time on stroop test (name and font different) than their female counterparts. Low emotional/sociable females performed better than their male counterparts in all the above groups.

   The high impulsive males significantly showed higher scores on stroop test (name and font different) and visual search test than their female counterparts. Low impulsive females performed better than their male counterparts in all the above groups.

4. **A × B × C Interactions:**

   High emotional/active/sociable males who had proper lunch significantly showed the greatest post-lunch dip on stroop test (name and font same) and stroop test (name and font different) than all other groups. Similarly, low emotional/active/sociable females who skipped their lunch performed the best in all the above groups.

   The, high impulsive males, who had proper lunch significantly showed greatest post-lunch dip in performance on stroop test (name and font different) and visual search test than all other groups. Similarly, low impulsive females who skipped their lunch performed the best in all the above groups.
III. In addition, an attempt was made to check the significance of differences between Pre-lunch and Post-lunch scores (means) for all the groups in all 16 experiments by correlated t-test. The results clearly indicated a post-lunch dip in performance in all the experiments.

IV. Moreover, a correlated t-test was applied to see the significance of differences between means of stroop test (name and font same) scores and stroop test (name and font different) scores. The test revealed no significant differences between the two.

It can be concluded, therefore, temperamental dimensions (emotionality, activity, sociability and impulsivity), lunch conditions (skipping of lunch, snacks in lunch and proper vegetarian lunch) and gender (male and female) differentially produce their independent as well as interactive effects on all cognitive tasks namely stroop test (name and font same), stroop test (name and font different), visual search test and digit span test.