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LUNCH AND SELECTIVITY IN MEMORY AND ATTENTION

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ABSTRACT

Background: Research in industrial settings and in the laboratory suggests that performance declines in the post-lunch period. Some evidence suggests that this post-lunch dip is due to the consumption of a meal, whereas other studies show that it reflects endogenous rhythms. The post-lunch dip is modified by factors such as personality, gender, meal type, and the nature of the task carried out. The present study examined whether the performance of tasks involving selectivity in memory and attention is impaired in the afternoon and whether this depends on consuming lunch. **Method:** A parallel-group design was used**.** One hundred and twenty university students (50% male) participated in the study. Baseline measurements were taken between 9.30 and 11.30 am. Volunteers were then assigned to one of five groups: (1) Pre-lunch testing, (2) Early afternoon post-lunch testing, (3) Early afternoon post- no lunch testing, (4) Late afternoon post-lunch testing, and (5) Late afternoon post- no lunch testing. In each session, cardiovascular measures were taken, mood was rated before and after the performance tests and tests measuring selectivity in memory and attention were carried out. **Results:** Heart rate was significantly higher after the consumption of lunch. At the start of the test session, mood ratings were less positive in the early afternoon if lunch was missed. At the end of the test session, consumption of lunch led to a more negative mood in the late afternoon, whereas those who fasted had a more negative mood in the early afternoon. None of the tasks measuring selectivity in memory and attention showed significant differences between the late morning and early afternoon. Similarly, the performance of these tasks showed no differences between lunch and no lunch conditions. **Conclusion:** The present study showed little evidence of performance of selective attention and memory tasks varying as a function of time of day or consumption of lunch. In contrast, pulse rate was influenced by lunch, and hedonic tone varied with the time of day, a finding that depended on when mood was measured and whether lunch had been consumed.

KEYWORDS: Lunch; Heart rate; Blood pressure; Mood; Selective Attention; Task Priority; Category Instances; Stroop Task; Biased probability choice reaction time.

INTRODUCTION

One common observation is that individuals often feel less alert and have difficulty maintaining attention in the post-lunch period. A review of early research on this topic[1] covered real-life activities and a number of diverse tasks that showed a drop in occupational performance (e.g. errors in reading meters, going to sleep while driving, missing warning signals, and minor accidents in hospitals). Research also showed a post-lunch dip in performance in controlled laboratory experiments, with a decrement being seen in vigilance, card sorting, serial reaction, calculations, and reaction time. What was unclear from the early studies was whether the post-lunch dip was due to consumption of the meal or endogenous circadian variation. Research using sustained attention tasks has often shown direct effects of lunch.[2,3] However, other research has shown that movement time was slower in the early afternoon than in the morning, and this effect was independent of the consumption of the meal.[4] Other tasks, such as those involving resistance to distraction, show no difference between late morning and early afternoon. It is also apparent that the post-lunch dip can be modified by individual characteristics such as personality, with stable extroverts and low anxious people showing the greatest post-lunch dip.[1] Gender is also important, with females reporting they were sleepier after lunch in one study and another only finding differences between lunch and no lunch conditions for males.[1]

It has also been shown that the nutrient content of the lunch may be important in determining effects on performance. For example, one study[5] showed that a high carbohydrate meal led to more focused attention, with slower reaction times to stimuli presented in the periphery. In contrast, a high protein meal led to more distraction from stimuli close to the target. Meal size has also been shown to be important.[6] Meal size did not affect reaction times to targets, but larger meals were associated with more occasional errors in both focused attention and search tasks. Stimulants may also reduce the size of the post-lunch dip. This has been shown using noise[7,8] which can increase alertness and also caffeine.[9]

The present project examined the effects of lunch on tasks involving selectivity in memory and attention. It has been suggested that reduced alertness may lead to changes in selective attention and memory, with a focus on the high probability/high priority/dominant aspect of the task. Alertness may be reduced in the post-lunch period. This was examined here by also measuring mood and cardiovascular function. The performance tasks used were based on studies of noise and selectivity.[10,13] Noise has been shown to reduce the effect of a distracting colour name in the Stroop Colour-Word test[14] and this task was used here. In terms of increased selectivity in memory, research[15] has shown that noise improves recall of high-priority information at the expense of information with a lower priority, and this task was used in the present study. Another task that has been used to demonstrate increased selectivity in memory when exposed to noise is the category instances task, which was also used in the present study.[16] In this task, the participant is shown a category name (e.g. An animal) followed by either a good example of that category (e.g., Cat) or a weaker example (e.g., Squirrel). People respond more slowly to the weaker example, and this effect is greater when performing in noise. The final task used here was a biased probability choice reaction time task. In this task, one stimulus is more probable than the others. Reaction times are faster to the more probable stimulus, and this effect has been shown to be greater in noise.[17]

In summary, the present study used a battery of tasks known to be sensitive to the alerting effects of noise to investigate whether there were differences in selectivity in memory and attention between the late morning and early afternoon and whether any differences reflected consumption of lunch.

METHOD

The study was approved by the Psychology Ethics Committee.

Study Design

Participants carried out a familiarisation session on a day prior to the main test day. All participants carried out a baseline session on the morning of the test day. They were then randomly allocated to one of the five experimental groups: pre-lunch test (N=24); afternoon test post-lunch (tested one hour after lunch, N=24; tested two hours after lunch, N=24); afternoon test no lunch (tested one hour after break, N=24; tested two hours after break, N=24). There were equal numbers of males and females in each group. Participants were tested at one or two times (early v late) in each of the afternoon conditions. The order of performance tests (forwards/backwards) was another between-subject factor. Participants did not remain in the laboratory throughout the experiment. They were asked to refrain from eating, drinking caffeinated or alcoholic drinks or smoking and from participating in vigorous physical activity during their time away from the laboratory. On returning, they were asked to record what they had been doing. The timing of the testing is shown in Table 1.

Table 1: Schedule of testing.

	EARLY	LATE
BASELINE	9.30 - 10.30	10.30 - 11.30
PRE-LUNCH	11.30 - 12.30	12.30 - 1.30
LUNCH BREAK	12.45 - 13.15	13.45 - 14.15
POST-LUNCH 1	14.15 - 15.15	15.15 - 16.15
POST-LUNCH 2	15.15 - 16.15	16.15 - 17.15

Participants

One hundred and twenty university students with a mean age of 20.4 +/- 2.4 years were recruited. They were given both written and verbal information regarding the study and were asked to sign a consent form. Each volunteer attended a familiarisation session prior to participating in the experiment. Exclusion criteria were taking medication, drinking more than 21 units of alcohol per week, and having clinically relevant current or past illnesses (e.g., hypertension or psychiatric disorders).

Nature of the meal

Participants chose a two-course meal from the range at the University refectory. The content of the meal was recorded along with information about their usual midday meal.

Mood rating

Mood was assessed both before and after each set of performance tests using 18 computerised bi-polar visual analogue rating scales (e.g. Drowsy-Alert; Happy-Sad).

Measurement of blood pressure and pulse

Blood pressure and pulse were measured before the test battery.

Category Instances Task

A category name was shown on the screen (e.g., ANIMAL) followed by either a dominant instance of that category (e.g. DOG) or a non-dominant instance (e.g., MOLE) or a non-instance (e.g., CHAIR). The participant had to respond "True" (by pressing a key with the left forefinger) if it was an instance and "False" (by pressing a key with the right forefinger) if it was not an instance. There were equal numbers of dominant and non-dominant instances and instances and non-instances. Reaction times were measured to the nearest msec using a timer card.

Stroop task

This task had four conditions. In the first, a square appeared on the computer screen and was either red, blue, green or yellow. In the second, the words red, blue, green or yellow were presented in black ink. In the first interference condition, a word was presented in the wrong colour (e.g., RED), and the person had to name the colour, ignoring the word. In the second interference condition, a word was presented in the wrong colour, and the participant had to respond to the word and ignore the distracting colour. The participant pressed the appropriate keys corresponding to each colour on a response box. In each condition, there were equal numbers of the four colours. Reaction times were measured to the nearest msec using a timer card.

Memory for high/low priority information

Eight words were presented in one of the four corners of the computer screen (two per corner). Each word was on the screen for 2 seconds with a one-second inter-word interval. The high-priority task was to recall the order of the words, and the low-priority task was to recall the location of the words. After the presentation of the words, the participant was given a random list of the eight words and had to indicate the order of presentation and then the location of each word.

Four-choice biased reaction time task

This task involved pressing the appropriate key on a response box when one of the letters A, B, C or D was presented. The stimuli were presented in the four corners of the screen. Three of the letters (B, C, and D) were presented 50 times, and the other (A) 100 times. Reaction times were measured to the nearest msec using a timer card in the computer.

Health-related behaviours

Questionnaires were administered to measure smoking, alcohol consumption, caffeine consumption, sleep and regular breakfast and lunch consumption.

Personality

Based on our previous research,[18] the following personality dimensions were measured: obsessional personality, extraversion, impulsivity, sociability and trait anxiety.

Analysis strategy

Initial analyses compared the experimental groups regarding psychosocial factors, health-related behaviours and baseline measures. Baseline performance was analysed to check that the selective attention and memory effects were present. Analyses of covariance (ANCOVAs) were performed to analyse the data. Separate analyses were carried out for each task. The scores from the test sessions were used as the dependent variables, and the baseline score for each task was used as the covariate. Significant main effects of the group were investigated using Scheffe tests. Planned comparisons for the effect of lunch and fasting conditions were also calculated if the main effect of the group reached significance.

RESULTS

Differences between the experimental groups: health-related behaviours

The five experimental groups were not significantly different in terms of age, smoking, units of alcohol consumed, caffeine consumption or hours of sleep. Similarly, they did not differ in terms of regular breakfast or lunch consumption.

Differences between the experimental groups: personality

There were no significant differences between the groups for any of the personality measures.

Differences between the experimental groups: baseline blood pressure and pulse

There were no significant differences between the groups for the cardiovascular measures.

Differences between the experimental groups: baseline mood

Pre- and post-test mood revealed the usual three factors (alertness, hedonic tone and anxiety). There were no significant differences between the groups for the baseline pre-test or post-test mood measures.

Differences between the experimental groups: baseline biased probability choice reaction time

This analysis showed a main effect of probability, with the A key being responded to more quickly (mean = 429 msec) than the lower probability keys (mean = 545 msec). The experimental groups did not differ in baseline performance of this task.

Differences between the experimental groups: baseline Stroop task

The expected differences between the speed of RTs in the different Stroop conditions were observed

- Name colour with interference from the word: mean RT =740msec
- Name word with interference from colour: mean RT =615 msec.
- Name word: mean RT=575msec
- Name colour: mean RT = 590 msec.

Differences between the experimental groups: baseline category instances task

Reaction times were faster for dominant instances of the categories (mean RT = 1171 msec) than non-dominant ones (mean RT = 1249 msec). There were no significant differences in the baseline performance of the experimental groups.

Differences between the experimental groups: baseline order/location task

The main effect of task priority was significant, with recall of order (mean = 4.6 words correct) being higher than recall of location (3.82 words correct). There were no significant baseline differences between the experimental groups.

Differences between the experimental groups: Summary

The experimental groups were well-matched in terms of demographics, personality and health-related behaviours. Mood and performance scores at baseline did not differ between the experimental groups. The expected within-task differences were observed for mood and performance tasks.

Effects of experimental groups

Blood pressure and pulse

A 3-way ANCOVA (experimental group x early/late x test order) was used to analyse measures of pulse and systolic and diastolic blood pressure. There were no significant differences between the groups for blood pressure, but the pulse readings were higher in those who had consumed lunch ($F (4,99) = 14.28$ $p < 0.0001$; Means: Pre-lunch: 66 bpm; Post-lunch early: 76 bpm; Post-lunch late: 78 bpm; Post-no lunch early: 64 bpm; Post-no lunch late: 70 bpm).

Pre-test mood

There was a significant effect of groups for hedonic tone ($F(4,99) = 2.59$ $p < 0.05$). Planned comparisons showed that those tested in the late morning had a more positive mood than the no-lunch group tested in the early afternoon (Means: Pre-lunch: 253; Post-lunch early: 244; Post-lunch late: 234; Post-no lunch early: 227; Post-no lunch late: 244).

Post-test mood

There was a significant effect of groups for hedonic tone ($F(4,99) = 3.58$ $p < 0.01$). Planned comparisons showed that consumption of lunch led to a more negative mood in the late afternoon ($p <0.05$), whereas those who fasted had a more negative mood in the early afternoon (Means: Pre-lunch: 186; Post-lunch early: 171; Post-lunch late: 163; Post-no lunch early: 167; Post-no lunch late: 177).

Biased probability choice reaction time task

There was no significant interaction between groups and the biased probability effect. Accuracy declined in the earlier afternoon for both those who consumed lunch and those who did not (F4,99) = 2.80 $p <0.05$).

Stroop task

There were no significant differences between the experimental groups on the Stroop conditions.

Category Instances task

There were no significant interactions between experimental groups and dominant/non-dominant instances for either speed or accuracy.

Order/Location task

The consumption of lunch and time of testing did not interact with the task priority effect.

DISCUSSION

Previous research has shown that performance in the early afternoon may dip and improve again later in the afternoon. This effect has been observed in both real-life activities and in the laboratory. Some research shows that the post-lunch dip depends on the consumption of lunch. This is often the case with sustained attention tasks. Other research suggests that some functions, such as motor speed, reflect endogenous rhythms rather than meal effects. Other tasks, including those that involve selectivity in memory and attention, appear to show little difference between late morning and early afternoon and do not change following the consumption of lunch. This last topic was examined here using a battery of tasks that have been shown to be changed by different activation states (e.g., noise and sleep deprivation).

The result showed that consumption of lunch increased heart rate but that no changes in heart rate or blood pressure were observed in other groups. Similarly, hedonic tone changed over the course of the day, with effects varying depending on when the mood was assessed (before or after the test battery) and whether lunch was consumed or not. Specifically, at the start of the test session, mood ratings were less positive in the early afternoon if lunch was missed. At the end of the test session, consumption of lunch led to a more negative mood in the late afternoon, whereas those who fasted had a more negative mood in the early afternoon. None of the tasks measuring selectivity in memory and attention were influenced by the consumption of the meal or time of testing.

One must now ask whether the methodology led to the absence of effects. The effects of lunch depend on factors such as the personality and gender of the participant, features of the meal and regular eating habits. The result showed that the experimental groups were well-matched in terms of demographics, personality, health-related behaviours and eating habits. In addition, a baseline measure was taken to adjust for unwanted differences in performance. Overall, the lack of effects of lunch and time of day does not appear to be due to unwanted individual differences.

One must also ask whether the performance tasks showed the desired effects of selective attention and memory. Analysis of the baseline data revealed that the selective effects of task parameters were present in all tasks. The effects of lunch on heart rate show that physiological changes were produced by the meal. Similarly, hedonic tone was shown to change as a function of time of day and meal consumption. Overall, the present results confirm previous findings[4] showing that lunch and time of day have little effect on measures of selective attention.

CONCLUSION

Research from the laboratory and the workplace shows that performance declines in the post-lunch period. Some research shows that this reflects the consumption of a meal, whereas other findings show that it is due to endogenous rhythms. The post-lunch dip can vary depending on factors such as gender, personality, the nature of the task, meal size, and

constituents. The present study examined whether tasks involving selectivity in memory and attention were impaired in the afternoon after lunch, and also after no meal. One hundred and twenty university students (50% female) took part in the study. Baseline measurements were taken between 9.30 and 11.30 am, and the participants were then assigned to one of five groups: (1) Pre-lunch testing, (2) Early afternoon post-lunch testing, (3) Late afternoon post-lunch testing, (4) Early afternoon post- no lunch testing, and (5) Late afternoon post- no lunch testing. Cardiovascular measures were taken, subjective mood was rated before and after the performance battery, and tests measuring selectivity in memory and attention were performed. Heart rate was significantly higher in the lunch conditions. Mood ratings at the start of the test session were less positive in the no-lunch group in the early afternoon. The mood rated at the end of the test session was more negative mood in the late afternoon in those who consumed lunch, whereas a more negative mood was reported in the early afternoon in those who fasted. There were no differences between the late morning and early afternoon for the tasks measuring selectivity in memory and attention. These tasks also showed no differences between the lunch and no lunch conditions. Overall, the present study showed little evidence of time-of-day effects or lunch effects in the performance of selective attention and memory tasks. Heart rate was influenced by lunch, and hedonic tone changed over time, with the pattern depending on whether lunch had been consumed and when mood was measured.

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