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SLEEP DEPRIVATION, LUNCH AND SELECTIVE ATTENTION

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ABSTRACT

Background: Previous research has demonstrated that both sleep deprivation and consumption of lunch are associated with impaired sustain attention. Less is known about their effects on selective attention, and this was examined in the present study. **Methods:** The present study examined the effects of one night of sleep deprivation on the performance of two selective attention tasks before and after lunch the next day. One task measured focused attention and examined funnel vision. The other task involved categoric search where the location of the target was not known. The participants were 12 males and 9 females, age range 18-24 years. The sleep-deprived group remained in the laboratory from 22.00. The pre-lunch condition was carried out at 11.15, lunch was given at 12.15, a post-lunch test was at 13.30, and a final session at 14.45. **Results:** The results showed that sleep deprivation was associated with slower reaction times in all versions of the tasks. The sleep-deprived group also showed greater funnel vision. In contrast, consumption of lunch was associated with slower reaction times in the categoric search task. **Conclusions:** Sleep deprivation is associated with psychomotor slowing and an increase in funnel vision. Consumption of lunch leads to slower reaction times when the location of the target is not known. These results have implications for the performance and safety of real-life activities.

KEYWORDS: Sleep deprivation; lunch; psychomotor slowing; funnel vision; visual search; selective attention.

INTRODUCTION

Research has shown that sleep deprivation impairs the ability to sustain attention.[1-3] One explanation of these effects is that sleep deprived individuals have micro-sleeps which cause these lapses of attention.[4] Others[4] have suggested that the micro-sleeps are a final stage in a more gradual reduction of alertness and that other impairments, such as psychomotor slowing and changes in selective attention, maybe apparent after a night without sleep.

Consumption of lunch leads to reduced alertness and impaired performance of sustained attention tasks.[5-7] The type of task that is impaired by the consumption of lunch involves uncertainty about when or where targets are going to occur. The differences between late morning and early afternoon reflect the consumption of the meal rather than endogenous circadian rhythms.[7] Other tasks, such as selective attention tasks, do not usually show post-lunch impairments.[8] However, the nutrient composition may affect different types of attention, with high protein meals leading to increased distractability, and high carbohydrate meals slowing responses to targets in the periphery.[9]

One of the problems with research on changes of state on attention is that the studies use different tasks to measure different attentional functions. Broadbent, Broadbent and Jones[10,11] overcame this problem by measuring aspects of attention with a choice reaction time task involving responses to the letters A or B. In the focused attention version, the target letter was always presented in the centre of the screen. On some trials, distracting letters were also presented at the sides of the target. Distraction was greatest when these letters differed from the target and were close to it. The focusing of attention, or funnel vision as it is sometimes called, could be measured by examining the difference between near and far distractors. When attention is focused, far distractors have less effect than when it is set to a wider angle. The second version of the task involved searching for a target based on category rather than a simple sensory feature such as location. In this task, the letter could occur in one of two possible locations and detection required two processes: "where is the letter?" and "what is the letter?" Both versions of the task also measured general response time, which meant that it was possible to assess the impact of sleep deprivation and lunch on psychomotor speed.

Studies of sleep deprivation have demonstrated that its effects on behaviour are modified by other factors.[4] Generally, factors which decrease alertness will increase the negative effects of sleep deprivation. Based on this view, one might predict that the reduction of alertness due to the consumption of lunch will lead to greater effects of sleep deprivation. However, previous research [12] could not confirm such effects.

In summary, the present research examined whether sleep deprivation and consumption of lunch would influence focused attention, categoric search and psychomotor slowing. It also investigated whether there would be an interaction between sleep deprivation conditions and pre-post-lunch performance, where the reduction in alertness induced by both changes in state could lead to greater impairments than either alone.

MATERIALS AND METHODS

The present study was carried out with the approval of the ethics committee, School of Psychology, Cardiff University, with the informed consent of the volunteers.

Design

After recruitment participants carried out familiarisation involving two sessions of the performance tasks. Participants were randomly assigned to the sleep-deprived or non-deprived condition. None of the participants were taking prescribed or OTC medication, and all were non-smokers.

Procedure

Those in the sleep-deprived condition arrived at the laboratory at 22.00 and during the night (until 06.00) carried out a series of performance tasks every two hours. From 06.00 until the first test session, they remained in the laboratory, were given breakfast, and allowed to read or watch a video. The non-sleep deprived group followed their normal sleeping routine.

The pre-lunch session was carried out at 11.15, and this was followed by lunch at 12.15. Lunch consisted of tomato soup, chicken and rice, and strawberries and cream (protein: 39g; Fat: 41g; carbohydrate: 118 g; Energy: 970 kcal; and weight: 870g). A post-lunch session took place at 13.30, followed by a final session at 14.45. Participants remained in the laboratory between sessions.

Volunteers

The participants were university students (10 males and 11 females, age range 18-24 years). Those in the sleep-deprived and non-deprived groups were of comparable body weight (sleep-deprived mean = 66.7 kg, SD = 10.0; non-deprived: mean = 68.9 kg, SD =7.3). Data collected at recruitment showed that there were no differences between the two groups for introversion, morningness, trait anxiety or sleeping/eating and drinking habits. They were paid for participating in the study.

Performance tasks

Focused attention task [10,11]

This choice reaction time task measured various aspects of performance. In this task, target letters appeared as upper case A's and B's in the centre of the screen. Participants were required to respond as quickly and as accurately as possible to the target letter presented in the centre of the screen, ignoring any distracters presented in the periphery. The correct response to A was to press a key with the forefinger of the left hand while the correct response to B was to press a different key with the forefinger of the right hand. Prior to each target presentation, three warning crosses were presented on the screen, and the outside crosses were separated from the middle one by either 1.02 or 2.60 degrees. The crosses were on the screen for 500 ms and were then replaced by the target letter. The central letter was either accompanied by 1) nothing; 2) asterisks; 3) letters which were the same as the target; or 4) letters which differed from the target. The two distracters presented were always identical, and the targets and accompanying letters were always A or B. Participants were given ten practice trials followed by five blocks of 64 trials. In each block, there were equal numbers of near/far conditions, A or B responses and equal numbers of the four distracter conditions. The nature of the previous trial was controlled. This test lasted approximately 10 minutes. In this task, the global measure of choice reaction time when the target was presented alone or when distracters were present was recorded. Funnel vision was calculated by the difference between near disagreeing distractors and far disagreeing distractors.

Categoric search task[10,11]

This task was developed to measure aspects of selective attention and choice reaction time. Each trial started with the appearance of two crosses in the positions 2.04 or 5.20 degrees apart. Volunteers did not know which of the crosses would be followed by the target. The letter A or B was presented alone on half the trials and was accompanied by a digit (1-7) on the other half. Again, the number of near/far stimuli, A versus B responses and digit/blank conditions were controlled. Half of the trials led to compatible responses (i.e. the letter A on the left side of the screen, or letter B on the right) whereas the others were incompatible. Volunteers were given ten practice trials followed by five blocks of 64 trials. In each block, there were equal numbers of near/far conditions, A or B responses and equal numbers of the four distractor conditions. The nature of the previous trial was controlled. The mean reaction time was the main measure of interest here.

RESULTS

Analyses of variance were carried out, with the sleep-deprived condition as the between subject factor and test sessions as the within subject factor.

Effects of sleep deprivation

The sleep-deprived group had significantly slower reaction times in both the focused attention (no distracting letters: $F_{1,19} = 6.53$ $p < 0.05$; distracting letters: $F_{1,19} = 5.08$ $p < 0.05$) and categoric search tasks ($F_{1,19} = 5.43$ $p < 0.05$; see Table 1). In addition, they showed greater funnel vision ($F_{1,19} = 20.50$ $p < 0.0005$; see Table 1).

Table 1: Effects of sleep deprivation.

(Scores are the means, SDs in parentheses)

	Non-sleep deprived	Sleep-deprived
Focused attention RT (msec) – no distracting letters	334 (74)	378 (102)
Focused attention RT (msec) – distracting letters	336 (49)	377 (81)
Categoric search RT (msec)	425 (74)	479 (78)
Funnel vision effect (msec; higher scores = greater funnel vision)	3 (13.1)	25 (25.2)

Effects of lunch
The only significant effect of lunch was slower responses on the categoric search task ($F_{2, 38} = 5.78$ $p < 0.01$). The typical post-lunch dip was seen, with reaction times being slower after lunch and then returning to pre-lunch levels later in the afternoon (see Table 2).

Table 2: The post-lunch dip in response times in the categoric search task (scores are the mean RTs, SDs in parentheses).

Pre-lunch (11.15)	After lunch (12.30)	Later in the afternoon (13.45)
453 (74)	470 (92)	449 (79)

Interactions
There were no significant interactions between sleep deprivation and sessions.

DISCUSSION
The results from this study show that one night of sleep deprivation leads to slower mean response times in both focused attention and categoric search tasks. In addition, sleep deprivation increases funnel vision, an effect that has been demonstrated in fatigued individuals with other tasks. The present results argue against a micro-sleep explanation of the effects of sleep deprivation. Lapses of attention due to micro-sleep may occur as a final stage prior to the person falling asleep. However, prior to that, the alertness of the person decreases, and this is associated with other behavioural changes such as psychomotor slowing and increased funnel vision.

In contrast, the effects of consuming lunch were restricted to the search task, where the typical post-lunch dip was observed. The present result also agrees with the suggestion that performance will be impaired after lunch if the person does not know when or where they have to respond. This can plausibly account for the post-lunch dip seen in real tasks such as driving.

There were no interactions between sleep deprivation and lunch which confirms earlier findings. Previous research[10,11,13-15] with the present tasks suggests a distinct profile of effects for different changes in state. Some variables, such as sleep deprivation and having a cold, influence global measures such as mean reaction time. Other factors, such as caffeine, influence the speed of encoding of new information, and reduce the number of lapses of attention. In the present study, lunch influenced the search task but not the focused attention task. Other factors, such as noise, impair the focused attention task but not the categoric search task. Time of day influences the focusing attention, but this effect is not modified by exposure to noise. These studies have compared changes of state in a choice reaction time task where a variety of measures can be obtained. The results support the view that different variables produce distinct profiles of effect which is consistent with the approach suggested by Hockey and Hamilton [16], and argue against interpretation in terms of a single dimension of arousal.

CONCLUSION
The present study examined the effects of sleep deprivation and consumption of lunch which are two factors that have been shown to reduce alertness. Participants carried out two versions of a two-choice reaction time task, one involving focused attention, and the other categoric search. Sleep deprivation led to a general psychomotor slowing and increased funnel vision. Consumption of lunch was associated with slower reaction times in the categoric search task. There were no significant interactions between sleep deprivation and the consumption of lunch. These results show that it is now possible to use a small number of measures from different versions of a choice reaction time task to investigate the effects of different activation states. These states appear to produce different profiles of effects which reflects the distinct CNS changes produced by them. The different changes may all be important in the safe performance of real-life activities which plausibly explains why impairments seen in the laboratory are also observed in safety critical activities such as driving.

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