Influence of a 30-min break on divided attention and working memory in resident anaesthetists on daily routine

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Background. The aim of this study is to test the hypothesis that a standard 30-min break in a routine 7.5 h period of work makes a difference in cognitive function.

Methods. In a double-blinded, cross-over trial 30 residents in anaesthesia were randomized to receive or not to receive a 30-min break between the assessment times of 07:30 and 14:00 in a normal working day. After at least 28 days the test was repeated with each resident in the opposite group. Primary outcome measure was the Test for Attentional Performance with the subtest of working memory and divided attention. Secondary outcomes are the Stanford Sleepiness Scale and the State-Trait Anxiety Inventory test.

Results. The sleep, caffeine and nicotine habits in both groups were comparable. There was no difference between the two groups in the Test for Attentional Performance, Stanford Sleepiness Scale and the State-Trait Anxiety Inventory. The correlation between recovery through sleep and sleep disturbance in the night before investigation to the Stanford Sleepiness Scale (P<0.001 and P=0.003) and State-Trait Anxiety Inventory (P<0.001 and P=0.001) at the 07:30 assessment is significant. For the 14:00 assessment the only significant correlation is between the recovery through sleep with the Stanford Sleepiness Scale (P=0.04) and the State-Trait Anxiety Inventory (P=0.05).

Conclusion. A 30-min break during a 7.5 h daily routine did not influence cognitive function tests.

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There is no doubt that partial sleep deprivation for on-call residents impairs clinical and cognitive function.1 On-call internal medicine residents have extended reaction times and reduced vigilance compared with the controls.3 By observing resident anaesthetists, Bartel and co-workers4 confirmed these results. It is clear that fatigue impacts on the performance of surgical skills.5,6 Sleep deprivation impairs work performance, cognitive function and subjective well being.3,7

However, to our knowledge, no data exist analysing the effect of a 30-min break on the cognitive function of anaesthetists in a routine day shift. The daily clinical routine of an anaesthetist indicates that one normally begins work at 07:30. On a typical workday the anaesthetist often does not get a break until late afternoon.

It is a major challenge and of crucial importance for an anaesthetist to maintain vigilance over a long period. There is no doubt that the work of an anaesthetist is a multitask one. Intact attention is an elementary precondition for the overall performance of the cognitive system. Working memory is central to controlling the flow of information. The divided attention capability of handling several simultaneous stimuli is absolutely essential for an anaesthetist. Therefore, in this study, we tested the hypothesis that a 30-min standard break in a routine 7.5 h period of work positively influences the cognitive function. The Test for Attentional Performance (TAP) along with the subtest of working memory and divided attention were used.

Methods
The study was carried out as a double-blinded, randomized, cross-over trial and took place in the Department of
Anaesthesiology, University Hospital, Aachen. The subjects were 30 residents in anaesthesia. Ethical approval was achieved and the anaesthetists were informed and agreed to participate in the study. There were 19 males and 11 females (age ranging from 25 to 39 yr, mean age 32 yr). Random allocation sequence was generated with the software ‘RandList Version 1.0 copyright DatIn’. In the first part the study subjects were randomly divided into two groups: one with and another without break. In the second part the same subjects were investigated in the opposite group (Fig. 1). Between part one and two there was at least 28 days.

Primary outcome measures were the working memory and divided attention and secondary outcomes of the Stanford Sleepiness Scale (SSS) and the State-Trait Anxiety inventory (STAI).

The study subject (allocation to the group) and the investigator assessing the study were blinded. The investigated subjects were only instructed according to a cognitive function study, but were not aware of the randomization criteria (having a 30-min break or not). The baseline assessment was conducted at 07:30 before operation and then repeated at 14:00 in both rounds (see Fig. 1). After the preoperative assessment the study subjects went straight to work. The anaesthetists were divided into operating rooms which, because of operating programmes, guaranteed uninterrupted work up to the 14:00 assessment. During the break period the study participant was released for a 30-min break by an additional anaesthetist between 12:00 and 13:30, and then returned to work. During the break they were allowed to eat, drink and recover in a recreation room.

For the 14:00 investigation the study subjects were similarly released and called to the testing room, which was used for both the 07:30 and 14:00 assessments. This prevented distraction from clinical routine and guaranteed an identical setting for the study subjects.

The first assessment was the computerized TAP (Version 1.7; Psytest, 2002). The core procedures are reaction time tasks of low complexity allowing the evaluation of very specific deficiencies. In this study the divided attention and working memory were tested. The first assessment was completed by the study subjects in about 25 min.

The divided attention performance is investigated by dual-tasks. In this examination, this is realized by a visual and an acoustical task. The visual task consists of crosses that appear in a random configuration in a 4×4 matrix. The subject had to detect whether the crosses form the corners of a square. The acoustical task includes a regular sequence of high and low beeps. The subject is instructed to detect an irregularity in the sequence.

The working memory test requires a continuous control of the information flow through short-term memory. For this, numbers are presented on the screen that must be compared with previously exposed numbers. The repetition of a number within a short interval has to be answered by pressing a key. The test was set at the highest level of difficulty.

As a measure of the test efficiency, the efficiency quality and efficiency speed are assessed. This is done by measuring reaction times and valid reaction. For the reaction time, all time measurements of valid reactions are rated. As a measure of efficiency quality the number of valid reactions is counted. These include all reactions, excluding false reactions, lapses or reactions outside a certain time gap.

The second assessment is determined by a questionnaire filled out by the study subjects. It followed on from the TAP. The questionnaire contained patient characteristic data and professional experience. Caffeine, nicotine and sleep habits were recorded. Further, the SSS and the Spielberger STAI were conducted at both time points. The SSS is a seven-point self-rating scale that quantifies progressive steps in sleepiness. The scale consists of seven statements which range from 1 to 7:1 indicating high alertness to 7 indicating imminent sleep.8 The Spielberger STAI is one of the most frequently used measures of anxiety in applied psychology research. It is a reliable and sensitive measure of anxiety. The questionnaire including 20 items measuring the state of anxiety (how one feels at the moment) was used at both time points.

**Statistical analysis**

The sample size was calculated with a power of β=0.8 and a significance level of α=0.05, considering a difference of...
20% as relevant. Median and SD were taken from TAP databases (age 18–45 yr; n=188 and n=230). The power was calculated with n=10 and n=24. Considering a sufficient reserve the group size to be analysed was determined with n=30. The power analysis was calculated with the SAS software version 8.0® (SAS Institute Inc.).

Patient characteristic data and professional experience are presented as mean and SD. Gender, marital status and children of the anaesthetist are shown as frequencies and percentage of total.

Average sleep duration, nicotine habits, caffeine habits and subjective recovery through sleep before investigation are tested with the two-tailed Wilcoxon's test and shown as mean and SD.

Sleep disturbance, caffeine and nicotine addiction of the anaesthetist are tested with the two-tailed Fisher’s exact test and shown in frequencies and percentage.

The TAP, SSS and STAI were calculated with the Pillai–Spur multivariate test and presented as mean, SD and 95% CIs.

The retest reliability is analysed with the one way ANOVA. The results are shown in mean and SD and 95% CIs.

Pearson’s correlation coefficient is conducted to analyse the correlations between recovery through sleep and sleep disturbances in the night before investigation at the primary and secondary outcome parameters.

Statistical analysis was performed using the SPSS software version 12.0® (SPSS Inc.).

### Results

In this study 30 anaesthetists, 11 female and 19 male were included. In the first part 15 anaesthetists were randomly allocated to receive a break and 15 did not receive one. In the second part 14 anaesthetists were analysed having no break and 12 had a break. Four of the anaesthetists included in the first part were excluded in the second part, as they had changed department or hospital. There were at least 28 days between the first and second investigations, with a mean value of 60.3 (22.7) days (Fig. 1). The average anaesthesia training was 4.1 (2.7) yr and the affiliation to the University Hospital, Aachen was 2.5 (1.6) yr (Table 1).

The sleeping habits, caffeine and nicotine usage were similar in both rounds (Table 2).

There is no difference between having a break or not for the overall divided attention with its subtest and for the working memory. The results of the SSS and the STAI were similar (Table 3). The baseline values for the primary and secondary outcomes of the study did not indicate any bias through retesting (Table 4). The retest reliability between the first and the second part of the study are given.

There is a significant correlation between the recovery through sleep in the night before the investigation with the SSS and the STAI at both the 07:30 and 14:00 time points (Table 5). The correlation between the sleep disturbance in the night before investigation with the SSS and the STAI was only significant at 07:30 (Table 5).

### Discussion

There was no difference in the TAP, SSS and STAI regardless of whether a break was taken or not. At the 07:30 time point there is a significant correlation between the SSS and the STAI concerning recovery through sleep or sleep disturbance during the night before the investigation. In the 14:00 assessment, sleep recovery correlates with the SSS.

The correlation between sleep loss and performance found in this study, is confirmed in a meta-analysis which indicates that sleep loss reduced physicians’ overall performance. There are some possible reasons for negative findings in the primary and secondary outcome measures in this study. Hofer-Tinguely and colleagues\(^{10}\) found that the performance of tasks improved after a rest for 1.5 h or a sleep break. However, there was an initial period of ‘rest inertia’ in the performance of individuals. The performance did not improve immediately but was improving over time. This might have affected the results of this study. The assessment was at 14:00 after having a break of 30 min between 12:00 and 13:30 or not. The time between the

| Table 1 Patient characteristic data. Age, year of training and affiliation of Clinic of Anaesthesiology in the University Hospital Aachen of the participating anaesthetists are given in mean (SD). Gender, marital status and children are presented in number n and percentage of total in brackets. |
|---|---|---|---|
| Year of training | 4.1 (2.7) yr | 4.1 (2.7) yr | 4.1 (2.7) yr |
| Affiliation to clinic | 2.5 (1.6) yr | 2.5 (1.6) yr | 2.5 (1.6) yr |
| Gender (female/male) | 11 (36.7%)/19 (63.3%) | 11 (36.7%)/19 (63.3%) | 11 (36.7%)/19 (63.3%) |
| Marital status (single/married) | 20 (66.7%)/10 (33.3%) | 20 (66.7%)/10 (33.3%) | 20 (66.7%)/10 (33.3%) |
| Children (yes/no) | 3 (10%)/27 (90%) | 3 (10%)/27 (90%) | 3 (10%)/27 (90%) |
break and the assessment might have been too short or a longer testing period (total test phase of about 40 min) may have been advantageous. Perhaps a typical working day is not long enough, or the break was too short to show a difference. However, this study was planned to cover the clinical routine of an anaesthetist as close as possible.

The anaesthetists studied in this trial are perhaps accustomed to work for periods without a formal break, and have developed strategies for handling such a long period of work.

The TAP was chosen for several reasons. The TAP is the standard device for measuring attention in German-speaking countries. It was introduced in 1992, and has been published more than 70 times. Details can be found at www psytest.net. It is available in several languages. Though the TAP has not been used in the context of such a study design, we feel the reason for the negative result is unlikely to be the TAP.

The SSS was applied in this study as it is commonly used and well accepted. A more detailed scale for measuring fatigue might have performed better, as for example the visual analogue scale for fatigue. The practicality of the study allows a possible bias through assessing the SSS straight after the TAP. This might have an effect on the results of the measured sleepiness.

The complexity of modern operating theatre management makes cognitive testing in a daily routine difficult, because

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The complexity of modern operating theatre management makes cognitive testing in a daily routine difficult, because

of variable conditions. Any form of practical and intellectual action can be significantly reduced by fading alertness, fatigue, decreased concentration and increased distraction. Therefore, we tried to minimize the variations as far as possible.

The influence of fatigue among anaesthetists on cognitive function and psychomotor performance is well known. A more detailed scale for measuring fatigue might have performed better, as for example the visual analogue scale for fatigue. The practicality of the study allows a possible bias through assessing the SSS straight after the TAP. This might have an effect on the results of the measured sleepiness. The complexity of modern operating theatre management makes cognitive testing in a daily routine difficult, because
gender, maternal status and level of training were comparable. The testing room was the same for all participants of the study.

In the primary and secondary outcome measures, the results showed no difference. But the importance of even small changes in cognitive function should not be neglected. It has been shown, that an 8–15% increase of psychomotor tests, including simple reaction time tests, correspond to a blood alcohol level of 0.05‰.41 2 These results cannot be directly compared with this study, as different reaction tests were used and a much smaller increase in reaction time was found.

The importance and necessity of regular breaks is irrefutable, although a regular break is often not possible because of workload and lack of staff. A study in general aviation has shown that controlled breaks counteract fatigue.13 Similarly, the European working time guidelines for an occupational driver demand a 30-min break after 6 h.

But in this study a 30-min break during a 7.5 h working day did not influence cognitive function tests. These results merit further studies to define other potential factors influencing cognitive function. Cognitive function testing in daily routine is rather difficult. Testing in anaesthesia simulation centres with a longer working period and longer testing of the cognitive function may be beneficial.

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