

Impact Of Sleep Restriction And Recovery On Motivation During Repeated Cognitive Performance Testing

Denise Lange^{1,2}, Eva Hennecke¹, Judith Fronczek³, Andreas Bauer³, Daniel Aeschbach¹, David Elmenhorst³, Eva-Maria Elmenhorst^{1,2}

1. German Aerospace Center, Institute of Aerospace Medicine, Cologne
 2. RWTH Aachen University, Institute of Occupational Medicine, Aachen
 3. Forschungszentrum Jülich, Institute of Neuroscience and Medicine, Jülich

Introduction and Purpose

Both motivation and sleep deprivation affect cognitive performance. Especially during long-lasting studies with repeated cognitive performance tasks there is concern that subjects will lose motivation over time. Results may be confounded due to changes in motivation.

Methods/Study design

36 healthy volunteers performed 55 cognitive performance tasks at three-hourly intervals in a 11-day inpatient study:

	Intervention group N=21; mean age 25.9 ± 3.6 years; 9 females	Control group N=15; mean age 27.5 ± 5.8 years; 5 females
Adaptation (+2)	8 h	8 h
Baseline 1	8 h	8 h
Baseline 2	8 h	8 h
Chronic Sleep deprivation 1	5 h	8 h
Chronic Sleep deprivation 2	5 h	8 h
Chronic Sleep deprivation 3	5 h	8 h
Chronic Sleep deprivation 4	5 h	8 h
Chronic Sleep deprivation 5	5 h	8 h
Recovery	8 h	8 h
Total sleep deprivation	2 h	2 h
Recovery	+8 h	+8 h

: Time in Bed
 : KSS + How motivated are you now?
 : Cognitive performance task

1= Very slightly or Not at All
 2= A Little
 3= Moderately
 4= Quite a Bit
 5= Extremely

Figure 1: Study protocol

After two baseline nights with 8 h time in bed (TIB) the intervention group underwent chronic sleep deprivation (CSD) for 5 nights (5 h TIB) with a following recovery night of 8 h TIB. The control group had the opportunity to sleep 8 hours every night. After that both groups were kept awake for 38 h, which was followed by a 10 h recovery night. Participants completed the Karolinska Sleepiness Scale (KSS) and a questionnaire about their motivation (from 1=very little/not motivated to 5=very motivated) at 6 p.m. on all days.

Results

Sleepiness increased in the course of chronic sleep deprivation and resulted in a significant difference after total sleep deprivation (TSD) between control and intervention group (Figure 2, A). A significant difference between the two groups according to motivation is already found at the fifth chronic sleep deprivation day (control: 3.0 ± 1.3 , experimental: 2.2 ± 0.6) and remained after recovery sleep (control: 3.1 ± 1.0 , experimental: 2.3 ± 0.6) and total sleep deprivation (control: 2.9 ± 1.3 , experimental: 1.8 ± 0.8) (see Figure 2, B).

Conclusions:

- Chronic sleep restriction for five days leads to an increase in sleepiness and a decrease in motivation
- One night of recovery is insufficient to reverse the motivation loss, contrasting with the beneficial effect on sleepiness
- Subjective motivation seems to decrease as a function of subjective sleepiness
- Without sleep loss, motivation remains high during long-lasting studies



Cognitive performance task results base on study design and not on motivation loss

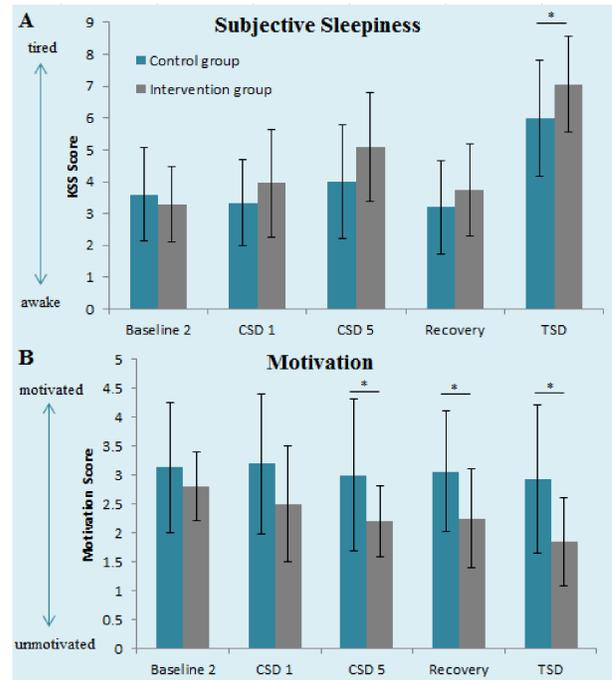


Figure 2: KSS (A) and Motivation (B) Score in control and intervention group.

A: KSS Score on total sleep deprivation for control group 6, for intervention 7.05 (p=0.0284)

B: Significant difference in motivation for chronic sleep deprivation 5 (p=0.0347), recovery (p=0.0205) and total sleep deprivation (p=0.0096).

Figure 3, A illustrates a significant increase in subjective sleepiness from baseline (3.3 ± 1.2 (SD)) to the first (4.0 ± 1.7) and last (5.1 ± 1.7) day of chronic sleep restriction for the experimental group. For total sleep deprivation, both groups show a highly significant increase in subjective sleepiness.

In comparison with baseline, motivation shows a significant decrease to the last day of chronic sleep restriction, to recovery and to total sleep deprivation for the experimental group.

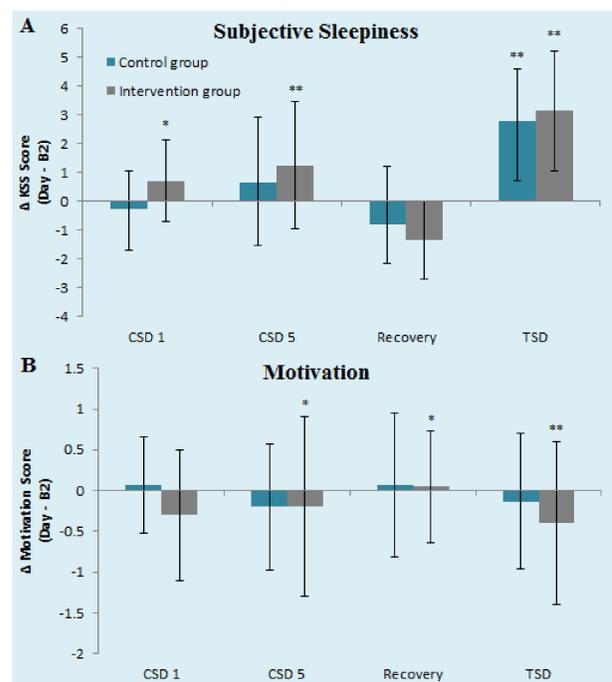


Figure 3: Δ KSS (A) and Motivation (B) Score between study-day and baseline.

A: Δ KSS Score is highly significant (control: p=0.0002, experimental: p=0.001) on total sleep deprivation.

B: Δ Motivation is significant on chronic sleep deprivation (p=0.0088), recovery (p=0.0164) and total sleep deprivation (0.0005).

Increase in sleepiness showed a significant Spearman correlation with loss of motivation ($r = -0.47$, $p < 0.001$).

