

COLD LEGS DO NOT MATTER

INVESTIGATING THE EFFECT OF LEG COOLING TO OVERCOME PASSIVE FATIGUE

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Motivation

Simulator studies investigating facial cooling (Schmidt et al., 2017) and hand cooling (van Veen, 2016) showed that those treatments invoked physiological arousal, which indicates sympathetic activation. This in turn reduced perceived fatigue and improved driving performance on simulated monotonous highways. Although, facial and hand cooling showed awakening effects, it had a negative impact on driver's comfort ratings. According to a laboratory study on leg cooling in a cold water bath by Janský et al. (2003), the treatment yielded an activation of the sympathetic nervous system. Inspired by water treading and its reported physiological effects, an investigation of leg cooling as a countermeasure against driver fatigue is worthwhile.

Results

- No significant differences between groups in terms of sleep duration in the night before the study and in initial KSS ratings.
- Increasing heart rate variability, eye closures and KSS ratings as well as decreasing skin conductance and pupil diameter indicate that participants developed fatigue over the course of the monotonous drive.
- Minute wise comparisons between the conditions were performed on continuously recorded data.
- In none of the 4 cooling minutes, the physiological measures of the COOL group are different to the measures of the CONT group.
- Driving performance was not affected by the treatment.
- Verbal assessment of fatigue after 5, 10 and 24 minutes of driving significantly increased pupil diameter and skin conductance.

Conclusion

Even though the participants perceived reduced fatigue, the physiological indicators do not align with this perception. Since skin conductance and pupil diameter were not affected by the stimulus, a sympathetic nervous system activation is ruled out. The lower KSS ratings by the participants may be due to a Placebo effect. Therefore, leg cooling at 15°C for a period of 4 minutes is not suited as a countermeasure against passive fatigue. It is also interesting to see that the verbal assessment of fatigue caused more sympathetic activation than the cooling. Future research should address colder temperatures, because those may yield a fatigue mitigating effect, as the laboratory study of Janský et al. (2003) has shown.

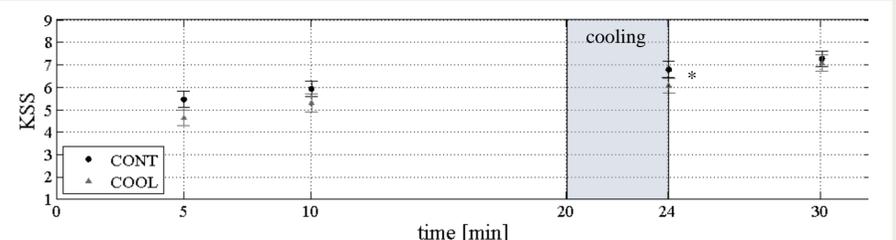
Research questions

- Which effect does 4-minute leg cooling have on subjective fatigue?
- Which reaction does leg cooling cause in skin conductance?
- Which reaction does leg cooling cause in pupil diameter?

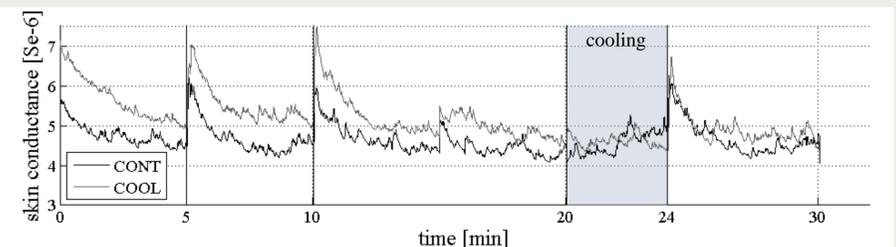
Method

- Simulator study with a between-subject design with 2 groups (21 participants each).
- Control group (CONT): 24°C for the entire drive.
- Cooling group (COOL): climate change from 24°C to 15°C between minute 20 and 24.
- Participants wore pants and T-Shirts and avoided caffeinated beverages before the study.
- Recordings of eye tracking, skin conductance, ECG and driving data.
- Questionnaires on subjective fatigue (KSS, Karolinska sleepiness scale) and thermal comfort (Bedford scale).

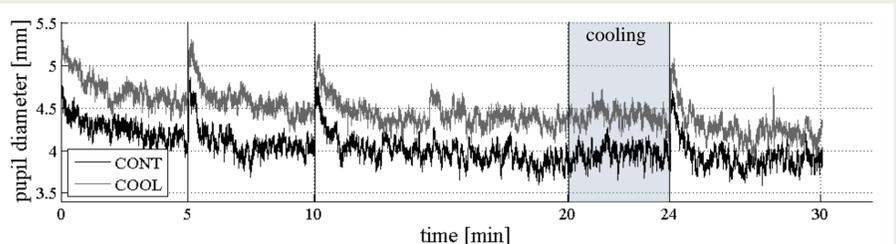
Subjective fatigue is **significantly reduced** directly after the stimulus.



Skin conductance level is **not affected** by the thermal stimulus.



Pupil diameters were **not affected** by the thermal stimulus.



References

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- Van Veen, S., 2016. Driver vitalization: Investigating sensory stimulation to achieve a positive driving experience. PhD thesis, TU Delft.

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