Effects of music and open window as countermeasures to driver sleepiness during day and night driving on real roads

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Summary
Sleepiness is a major risk factor for road accidents [1]. Listening to music and opening the window are among the most popular countermeasures, being more often applied than intake of caffeine and napping [2]. Yet, in the driving simulator, music and cold air were shown to be not sufficient as countermeasures to driver sleepiness [3], which might be due to a simulator effect. The present study investigated if opening the window and listening to music were effective against driver sleepiness during real road driving. Applying these in-car countermeasures showed significant, but only minor and transient effects in counteracting driver sleepiness and they are unlikely to be of any practical significance.

Results

Subjective sleepiness:
• Including the countermeasure application significantly improved the model fit for subjective sleepiness ($\chi^2 (1) = 5.22; p = .022$). Empirical Bayes Estimates for individuals are shown in figure 1.
• The effect was limited to the actual countermeasure application interval and estimated to be minor (-0.16 KSS steps) compared to the pronounced effects of night driving (+1.5 KSS steps) and driving duration.

Driving performance:
• Including the countermeasure application improved the model fit for SDLAT ($\chi^2 (1) = 6.41; p = .001$).
• The effect was limited to the actual countermeasure application interval (figure 2).
• A relatively large residual error in the SDLAT model indicated that also other factors such as road conditions influence this parameter.

Physiological sleepiness:
• Condition and driving duration had significant effects on KDSmax ($p < .05$).
• The factor group or interactions with group were not significant.

Methods

Sample:
• Control group: 8 healthy participants (4 female, mean age+SD: 38.75±10.55years).
• Countermeasure group: 16 healthy participants (8 female, mean age+SD: 43.13±8.93years).

Experimental Design:
• 90 min driving on a highway during day and night.
• Experimental group: received countermeasures open window and music for 10 minutes in intermittent intervals. The timing was based on (i) driving duration during the day, (ii) subjective sleepiness during the night.

Measures:
• Subjective sleepiness: Karolinska Sleepiness Scale (KSS) (every 5th minute).
• Driving performance: Standard Deviation of Lateral Position (SDLAT).
• Physiological sleepiness: Karolinska Drowsiness Score (KDS), which is based on Alpha-Theta activity in the EEG and slow eye movements.

Statistical Analysis:
• Multilevel mixed effects linear regression models were fitted for KSS and SDLAT using the STATA 11.1 procedure xtmixed. Likelihood Ratio Tests were applied to evaluate nested models.
• KDSmax was analysed using repeated measurements ANOVA.