Title: Sleepiness and the effect on driving - Professional drivers vs. non-professional drivers

Authors: *Anna Anund* (corresponding), Swedish National Road and Transport Research Institute, Linköping, Sweden, email: anna.anund@vti.se, tel. +46 709 218287; Rehabilitation Medicine, Linköping University, Linköping

Carina Fors, Swedish National Road and Transport Research Institute, Linköping, Sweden, email: carina.fors@vti.se

Christer Ahlström, Swedish National Road and Transport Research Institute, Linköping, Sweden, email: christer.ahlstrom@vti.se

Problem

It is well known that driver fatigue causes incidents and crashes (Hanowski, Wierwille, & Dingus, 2003; Horne & Reyner, 1995; Åkerstedt et al., 2013). However, there are large differences between individuals in how they are affected by fatigue (Ingre, Akerstedt, Peters, Anund, & Kecklund, 2006; Van Dongen, 2007), and little is known about these individual differences. Is it, for example, possible to learn how to drive without decreased performance under high levels of sleepiness? Here we investigate the development (and effects) of sleepiness in normal drivers versus professional drivers who are used to night work.

Method

Thirty participants (15 professional drivers – 15 passenger car drivers) were randomly selected from the register of Swedish vehicle owners. Inclusion criteria were: 18–25 year old males, self-reported evening persons, BMI < 30, no sleep disorders, no extremes in terms of self-reported personalities (extrovert or introvert), and self-reported normal sensitivity to stressful situations. Professional drivers were defined as those driving a heavy vehicle as a profession.

The within-subject design study took place in an advanced moving base simulator at the Swedish Road and Transport Research Institute (VTI)[1]. To manipulate sleepiness, factors for daytime and night-time driving were used (daytime between 12.30 and 21.15, night-time between 22.00 and 06.15). The participants visited VTI at 6 separate occasions (3 days and 3 nights), and at each visit they drove 3 different scenarios. The first daytime and night-time visits were excluded and considered as training. In this paper, four rural road driving sessions were included – daytime with simulated daylight and night-time with simulated darkness, repeated at two occasions.

Indictors of sleepiness used in the study were: self-reported sleepiness (KSS) reported every fifth minute, blink duration measured via electrooculography, number of line crossings and average speed.

A mixed model Anova was used to analyze differences in sleepiness and performance between professional drivers and passenger car drivers. The model included factors for time of the day (Day/Night), time on task (1–6 corresponding to block of 5-10-15-20-25-30 minutes), and professional (Yes/No). Participant was used as a random factor. The same method was used to analyze the effect on performance (line crossings and speed) on the same level of sleepiness for the two type of driver groups. The model included factors for KSS group (1–5; 6–7; 8–9), Blink duration (<0.12ms; 0.12–0.15ms; >0.15ms); Time of the day (Day/Night) and Professional (Yes/No). All analysis was done on blocks of 5 minutes and significance levels were set to 0.05.

[1] (http://www.vti.se/en/research-areas/vehicle-technology/driving-simulation/)

Results

Professional drivers reported significantly lower levels of self-reported sleepiness both daytime and night-time ($F=4.914$; $p<0.05$), Figure 1. Blink duration showed no significant difference in main effect for the two groups of drivers, but a significant interaction between type of driver and time of the day ($F=27.840$; $p<0.05$), with longer blink durations for professionals during night-time. Just as for blink duration, professionals had significantly more line crossings during night-time compare to passenger car drivers ($F=23.587$; $p<0.05$).

The professionals did not drive faster than passenger car drivers.

There was a significant correlation between KSS and blink duration ($r=0.477$; $p<0.05$). Longer blink durations were found for professional drivers for high KSS levels during night-time, see Figure 2. The pattern was the same for speed and for line crossings, with more line crossings and less speed reduction at high KSS levels for professionals compared to passenger car drivers. For speed there was a significant interaction between professionals*KSS group*blink duration ($F=3.080$; $p<0.05$) showing that professionals had more line crossings night at lower levels of KSS, but higher levels of blink durations, this was also the case for line crossings ($F=5.180$; $p<0.05$).

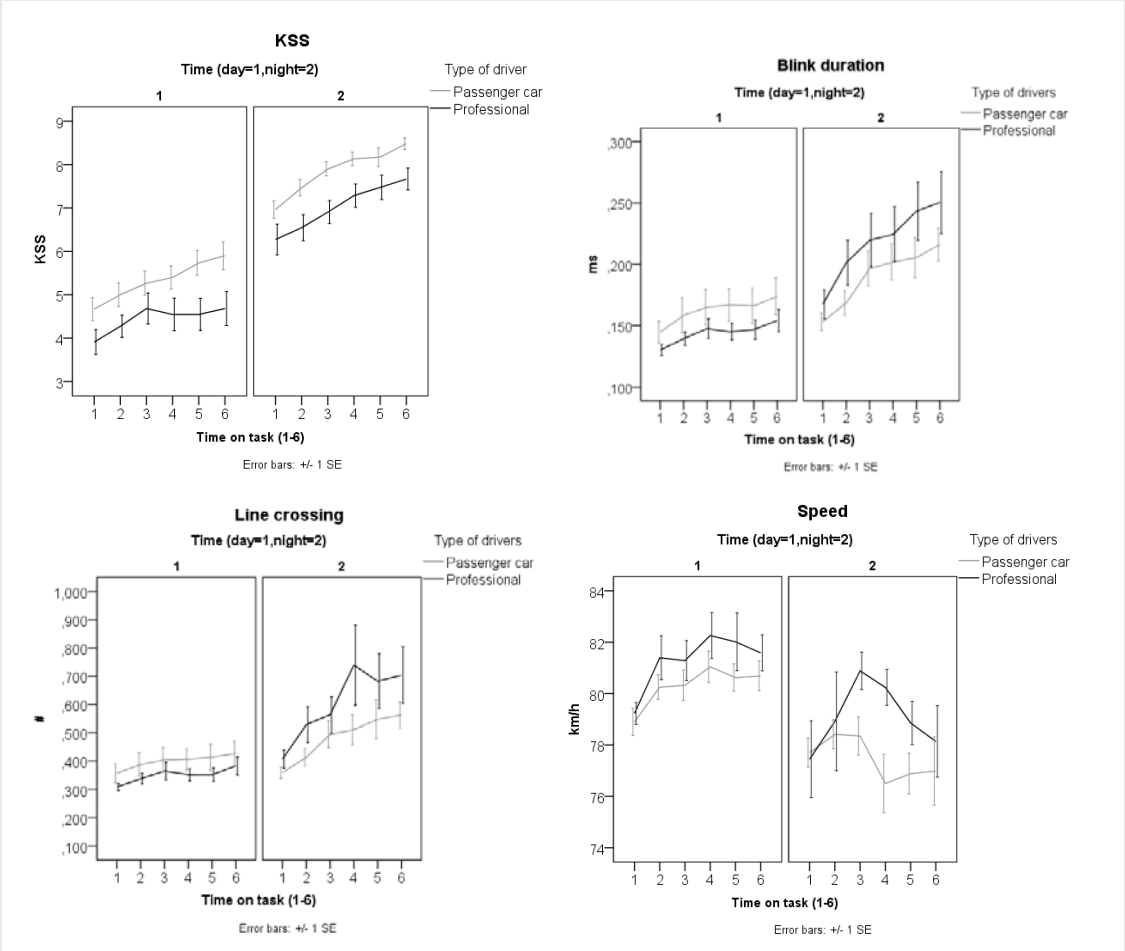

Figure 1. Karolinska sleepiness scale (KSS), blink duration, line crossings and speed for professional versus passenger cars drivers. Factors for time on task (1–6); time of the day (1=daytime; 2=night-time) and professional (Prof/Passenger car). The error bars represent standard error of mean.

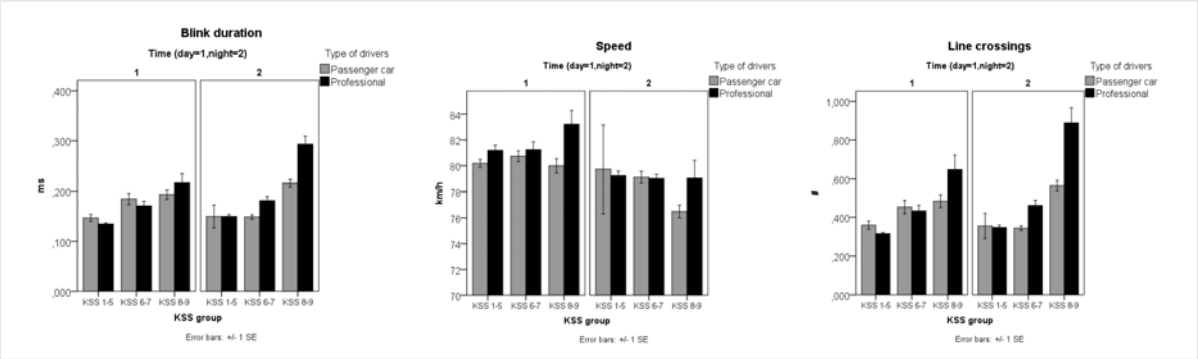

Figure 2. Blink duration, speed and line crossings for professionals versus passenger car drivers presented by KSS groups (1–5; 6–7; 8–9), factored by time of the day (1=daytime; 2=night-time). Error bars represent standard error of mean.

Discussion

The results show that professional drivers underestimate their sleepiness by reporting less subjective sleepiness than passenger car drivers while having longer blink durations and more line crossings, especially during night-time driving. Hence, there is no reason to believe that professional drivers are able to learn how to stay awake while driving in a better way than less experienced drivers. The reason for this is not known. One explanation might be that professional drivers are used to high levels of sleepiness during daily work, masking the true sleepiness. Interestingly, professional drivers had more line crossings than passenger car drivers during night-time, especially for high KSS levels, indicating that they are not better at handling sleepiness compared to passenger car drivers.

A limitation with this study is the very low age of the drivers. A topic for future research is to investigate whether the results generalize to a population with more experienced drivers.

Summary

Professional drivers reported less subjective sleepiness (KSS) both daytime and night-time compared to passenger car drivers. There was no main effect for blink duration, but a significant interaction with time of the day, with longer blink duration's during night-time for professional drivers. There was no significant effect between the two groups on the number of line crossings, but a significant interaction with time of day show that there are more line crossings for professional drivers during night-time. For speed there was no significant difference between the groups and no interactions. Looking at how the groups perform under the same levels of sleepiness, it was noticed that at high levels of KSS (8–9) during night-time, the professionals had more line crossings and did not reduce their speed as much as passenger car drivers did.

References

Hanowski, R., Wierwille, W., & Dingus, T. (2003). An on-road study to investigate fatigue in local/short haul trucking. *Accid. Anal. and Prev., 35*(2), 153-160.

Horne, J., & Reyner, L. (1995). Driver sleepiness. *J. Sleep Res., 4*(2), 23-29.

Ingre, M., Akerstedt, T., Peters, B., Anund, A., & Kecklund, G. (2006). Subjective sleepiness, simulated driving performance and blink duration: examining individual differences. *J. Sleep Res., 15*(1), 47-53. doi: 10.1111/j.1365-2869.2006.00504.x

Van Dongen, H. P. A. a. e., Mott, C.G.b , Huang, J.-K.c , Mollicone, D.J.b d , McKenzie, F.D.c , Dinges, D.F.d (2007). Confidence intervals for individualized performance models. *Sleep, 301*(9), 1083

Åkerstedt, T., Hallvig, D., Anund, A., Fors, C., Schwarz, J., & Kecklund, G. (2013). Having to stop driving at night because of dangerous sleepiness - awareness, physiology and behaviour. *Journal of Sleep Research*. doi: 10.1111/jsr.12042