[Exploring Driver's self-report and observer ratings of driver drowsiness based on real road driving]

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Introduction

- According to the European Road Safety Observatory (2018), 10 to 20% of crashes are due to drowsiness or fatigue. Consequently, the driver drowsiness is a key topic addressed in the driver road safety framework.
- Driver's alertness and attention impairment is assessed traditionally by 3 means:

- **The neurophysiological assessment** (EEG, ECG, EMG, EDA), Anund et al., 2008; Sparrow et al., 2019; Hu & Lodewijks, 2020.

- **The Behavioural and performance assessment**: including eye tracking studies, vehicle signals analysis (Wierwille et al, 1994; Friedrichs & Yang, 2010; Zhang et al., 2016); etc.

- **The Subjective assessment**: including the Karolinska Sleepiness Scale (KSS) rating with which the driver estimates his own alertness and sleepiness states (Akerstedt & Gillberg, 1990; Akerstedt et al., 2016).

Objectives

- The main objective of our real road study was to compare driver self-reports using Karolinska Sleepiness Scale (KSS) and trained observer ratings in order to address the following questions:
- Are driver self-reports sufficient to assess sleepiness and build accordingly a database leading to validate a system that monitor driver drowsiness?
- Do observer ratings provide additional values to strengthen driver drowsiness assessment and robustify consequently the system validation database?

Methods

- **Participants**

The study included 50 participants having valid driving licence with 50% male and 50% female. Their age ranged between 20–65 years old and more (average: 40.18 years; SD: 15.39), and they drove regularly. The participants were recruited with the help of medical experts of sleep located in the south-west of France.

- **Procedure**

Each participant performs 2 driving sessions: one driving for baseline and another for drowsiness session. The baseline session, **condition A,** in which the participants are not deprived of sleep**.** The drowsiness session, **condition B,** in which participants have deprived of sleep.

Methods

The participants provided their self-estimations of sleepiness each 5 minutes during both conditions, using the 9 levels of Karolinska Sleepiness Scale (KSS), Åkerstedt T, Gillberg M (1990): KSS level 1 means "extremely alert" until KSS level 9 meaning "Very sleepy, great effort to keep awake, fighting sleep". E.E.G device was also used as ground truth.

The Figure 1 below, summarizes the protocol

***Fig. 1.** Summary of the driving protocol*

- **Observer Ratings**

Six trained observers rated driver state, twice for the same video, by using observable drowsiness parameters (e.g: blink frequency, eye closure; yawning; movements on seat etc.) defined by human factor experts on the driver drowsiness topic. The average concordance rate of the observer judgements about drowsiness state is 0.92.

Results

- **Result 1: Ratings In each Driving Condition**

The results showed that for both observer ratings and driver self-reports, the mean estimation of drowsiness in driving condition B (with sleep deprivation) is higher than the mean observer ratings in driving condition A (without sleep deprivation). Kruskal-wallis test showed significant differences between Condition A and Condition B for Observer ratings (H=682, 85; $P < 0.0000$) as well as for drivers' self-reports (H=1047, 73; $p < 0.0000$) . See **Figure 2 and Figure 3.**

- **Result 2: Differences Between Observer ratings and Driver Self-Reports**

The results showed significant differences between observer ratings and driver self-reports, Kruskal-wallis test showed: (H=252, 44; $p < 0.0000$) for condition A and (H=0, 11; $p < 0.0000$) for condition B. . See **Figure 4 and Figure 5.**

Condition A		Observer Ratings	
		Not drowsy (KSS <7)	Least drowsy KSS (=7)
EEG Outputs	Not drowsy	**100.00%**	0.00%
	Least drowsy	100.00%	**0.00%**

Condition A		Driver Self-Reports	
		Not drowsy (KSS <7)	Least drowsy KSS (=7)
EEG Outputs	Not drowsy	**100.00%**	0.00%
	Least drowsy	100.00%	**0.00%**

***Fig. 4.** Confusion Matrix showing drivers' state from E.E.G outputs (Objective data), Observer ratings and drivers' self-reports for driving condition without sleep deprivation (Condition A.)*

Results

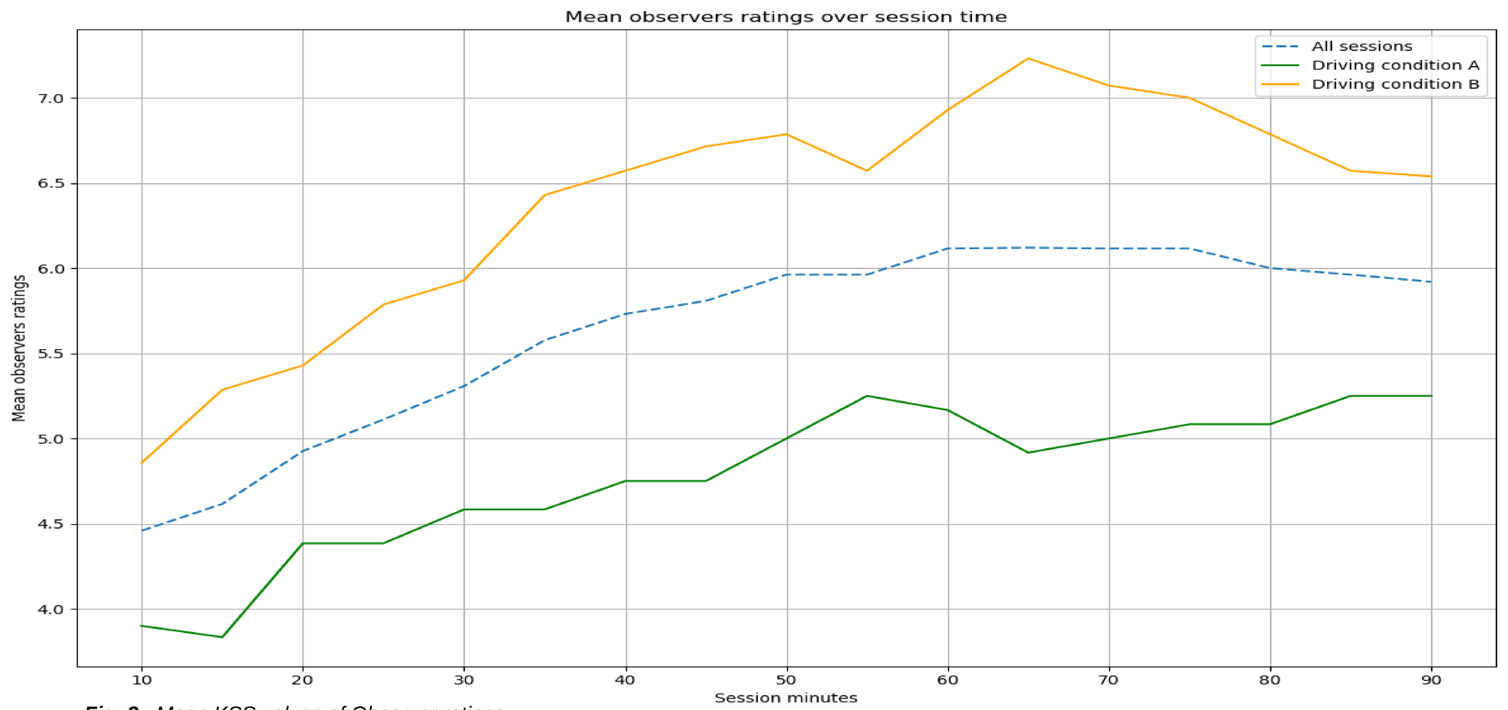

***Fig. 2.** Mean KSS values of Observer ratings*

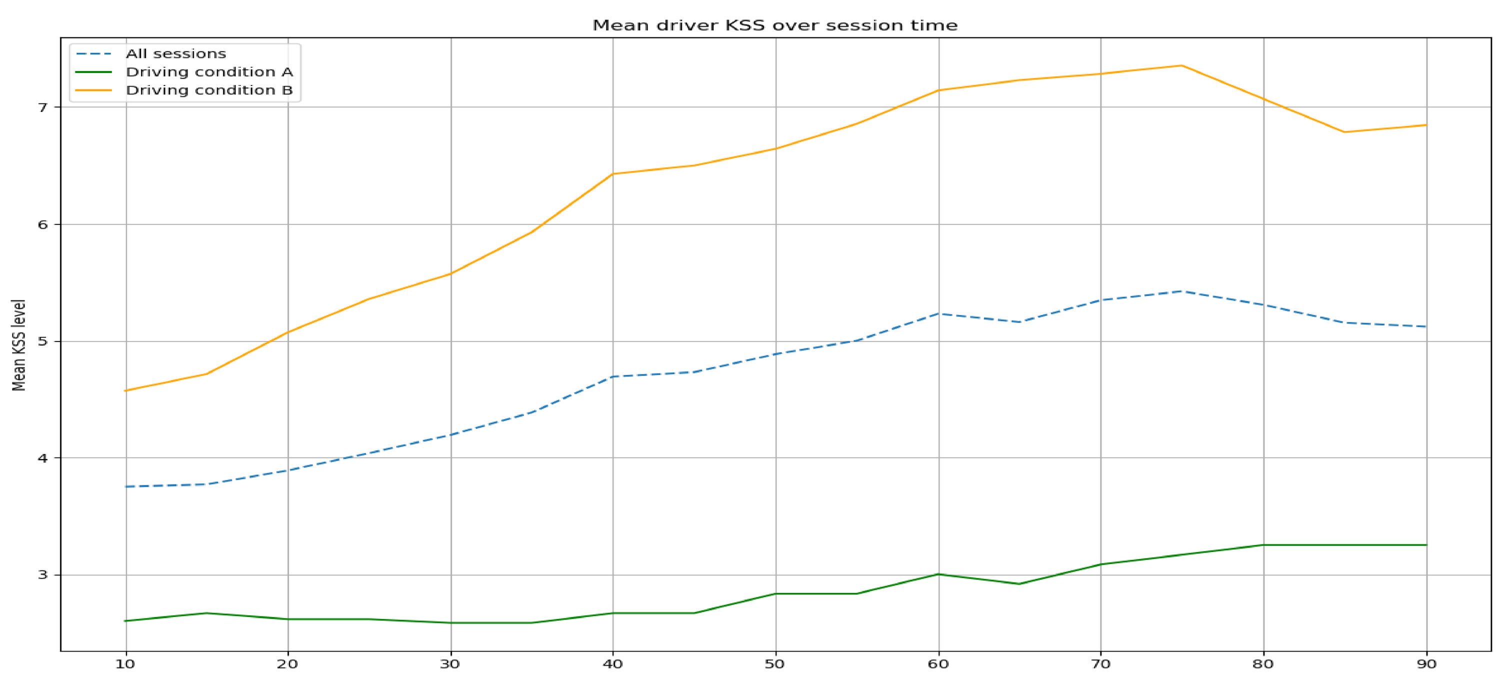

***Fig. 3.** Mean KSS values of Driver's Self-reports*

Condition B		Observer Ratings	
		Least drowsy KSS (=7)	Drowsy (KSS >=8)
EEG Outputs	Least drowsy	**74.51%**	25.49%
	Drowsy	5.88%	**94.12%**

Condition B		Driver Self-Reports	
		Least drowsy KSS (=7)	Drowsy (KSS >=8)
EEG Outputs	Least drowsy	**65.38%**	34.62%
	Drowsy	12.50%	**87.50%**

***Fig. 5.** Confusion Matrix showing drivers' state from E.E.G outputs (Objective data), Observer ratings and drivers' self-reports for driving condition with sleep deprivation (Condition B.)*

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Conclusions

- Both Oberver ratings and driver self-reports recognize the drowsiness state, but obsevers are closer to EEG objective data than drivers.
- The two methods are complementary measures for validation database.

References

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