



# Reliability of simulator driving tool for evaluation of sleepiness, fatigue and driving performance<sup>☆</sup>

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## ABSTRACT

**Study objective:** To compare the impact of extended wakefulness (i.e., sleepiness) and prolonged driving (i.e., fatigue) at the wheel in simulated versus real-life driving conditions.

**Design:** Participants drove on an INRETS-MSIS SIM2 simulator in a research laboratory or an open French highway during 3 nocturnal driving sessions. A dose–response design of duration of nocturnal driving was used: a 2 h short driving session (3–5 AM), a 4 h intermediate driving session (1–5 AM) and an 8 h long driving session (9 PM–5 AM).

**Participants:** Two groups of healthy male drivers (20 for simulated driving and 14 drivers for real driving; mean age  $\pm$  SD = 22.3  $\pm$  1.6 years), free of sleep disorders.

**Measurements:** Number of inappropriate line crossings, self-rated fatigue and sleepiness were recorded in the last hour of driving sessions to control the effects of prior waking time and time of day.

**Results:** Compared to the daytime reference session, both simulated and real driving performance were affected by a short nocturnal driving session ( $P < .05$  and  $P < .001$ , respectively). Extension of nocturnal driving duration affected simulated performance nonlinearly and more severely than that of real driving ( $P < .001$ ).

Compared to the daytime reference session, short nocturnal simulated and real driving sessions increased self-perceived fatigue and sleepiness. Real and simulated driving conditions had an identical impact on fatigue and sleepiness during extended periods of nocturnal driving.

**Conclusions:** In healthy subjects, the INRETS-MSIS SIM2 simulator appropriately measures driving impairment in terms of inappropriate line crossings related to extended wakefulness but has limitations to measure the impact of extended driving on drivers' performance.

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## 1. Introduction

Driving during the night for long periods is a significant cause of road accidents, particularly on highways (Horne and Reyner, 1995; Pack et al., 1995; Philip et al., 1996; Mitler et al., 1997; Sagberg, 1999). In addition to a disruption of circadian rhythms (Benoit and Foret, 1988; Mitler et al., 1997), two other symptoms combine to contribute to deteriorate driving performances. The first

one is sleepiness. This symptom is mainly due to extension of wakefulness (homeostatic and/or chronobiological influences) (Borbely, 1982; Akerstedt and Folkard, 1995). Sleepiness at the wheel is a well-known risk factors for traffic accidents, particularly on highways (Horne and Reyner, 1995; Philip et al., 1996, 1999, 2001; Sagberg, 1999; Garbarino et al., 2001; Sagaspe et al., 2008). The second symptom is fatigue which is known to occur when driving requires sustained attention over long periods of time (Lal and Craig, 2001; Thiffault and Bergeron, 2003; Ting et al., 2008). Fatigue has been shown to significantly decrease real driving performance during prolonged and monotonous driving (Lal and Craig, 2001; Sagaspe et al., 2008).

These symptoms (i.e., fatigue, sleepiness) combined with time of day contribute to a deterioration of drivers' performance when they drive for hours at night, but even so many drivers combine

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