



# Predicting driver's hypovigilance on monotonous roads Literature review

Grégoire Larue, Andry Rakotonirainy & Anthony Pettitt

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# THE PROBLEM: MONOTONY

- Definition <sup>[1]</sup>
  - lack/repetitive stimulation
- Types
  - task
  - environment
- Issues
  - no countermeasure
  - entangled with fatigue
- Aim

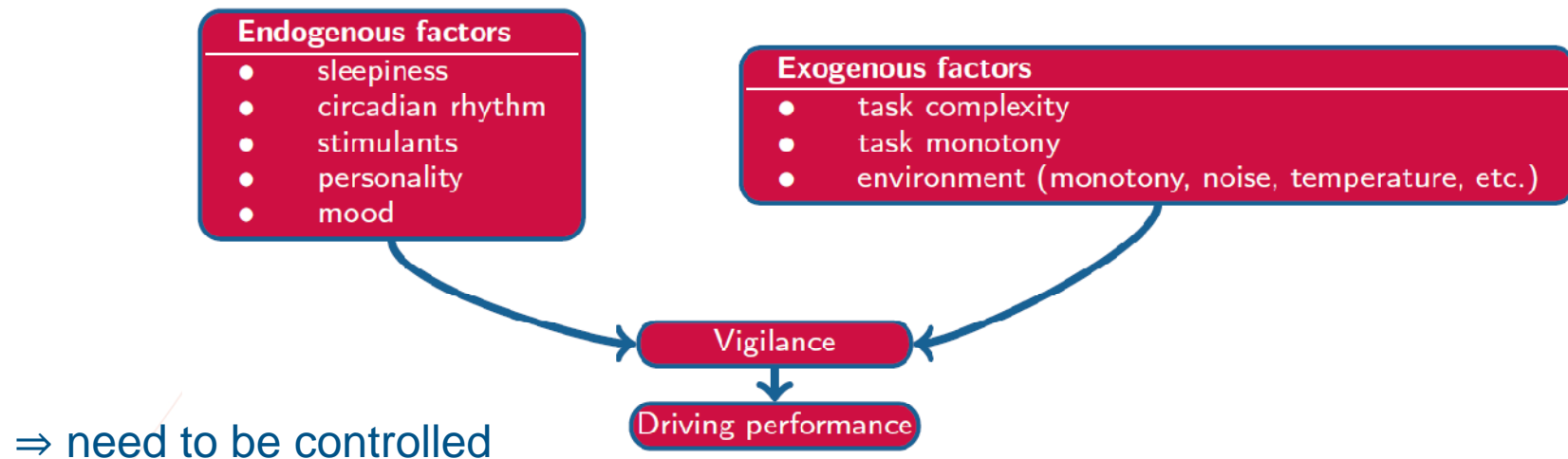
predict vigilance decrement due to  
monotony in real time



[1] Straussberger, S., 2004. A psychophysiological investigation of the concept of monotony in ATC: Effects of traffic repetitiveness and traffic density. 2004 Road Safety Research, Policing and Education Conference (Perth)

# MONOTONY AND DRIVING

- Cognitive consequences  
⇒ vigilance decrement (not directly observed)
- Consequences on driving performance  
⇒ observable (surrogate measures)
- Other factors lead to same consequences



[1] Thiffault, P., J. Bergeron (2003). Monotony of road environment and driver fatigue: a simulator study, *Accident Analysis & Prevention*, vol.35, pp.381-391.

# ASSESSMENT METHODS

Vigilance [1]	Driving performance [2]
<ul style="list-style-type: none"><li>• Requirements<ul style="list-style-type: none"><li>– objective</li><li>– reliable</li><li>– continuous</li><li>– non intrusive</li></ul></li><li>• Potential approaches<ul style="list-style-type: none"><li>– subjective assessment</li><li>– behavioural measures<ul style="list-style-type: none"><li>• reaction times</li></ul></li><li>– physiological measures<ul style="list-style-type: none"><li>• EEG, EOG, EMG, HR, EDA</li></ul></li></ul></li><li>• Choice: EEG</li></ul>	<ul style="list-style-type: none"><li>• Driver<ul style="list-style-type: none"><li>– eye blinks (duration/frequency)</li><li>– PERCLOS</li></ul></li><li>• Car<ul style="list-style-type: none"><li>– speed variance</li><li>– steering wheel movement</li></ul></li><li>• Environment<ul style="list-style-type: none"><li>– lateral position</li><li>– time to lane crossing</li></ul></li></ul>

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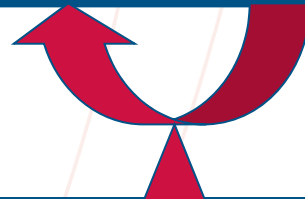
# ASSESSMENT WITH EEG

Condition	$\alpha$ band	$\beta$ band	$\delta$ band	$\theta$ band
Alert	attenuated when relaxed	preponderant		
Transition to drowsiness/fatigue	$\searrow$	sharp $\searrow$	$\nearrow$	$\nearrow$
Transition to alertness	$\nearrow$	$\nearrow$	$\searrow$	$\searrow$
Drowsiness	cycle of $\downarrow$ and $\uparrow$ (onset)		$\nearrow$	$\nearrow$ (advanced)
Fatigue	$\nearrow$			$\nearrow$
Monotonous tasks	$\nearrow$ frontal, parietal			
Microsleeps	bursts			bursts



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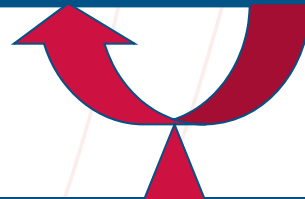


Mathematical model	
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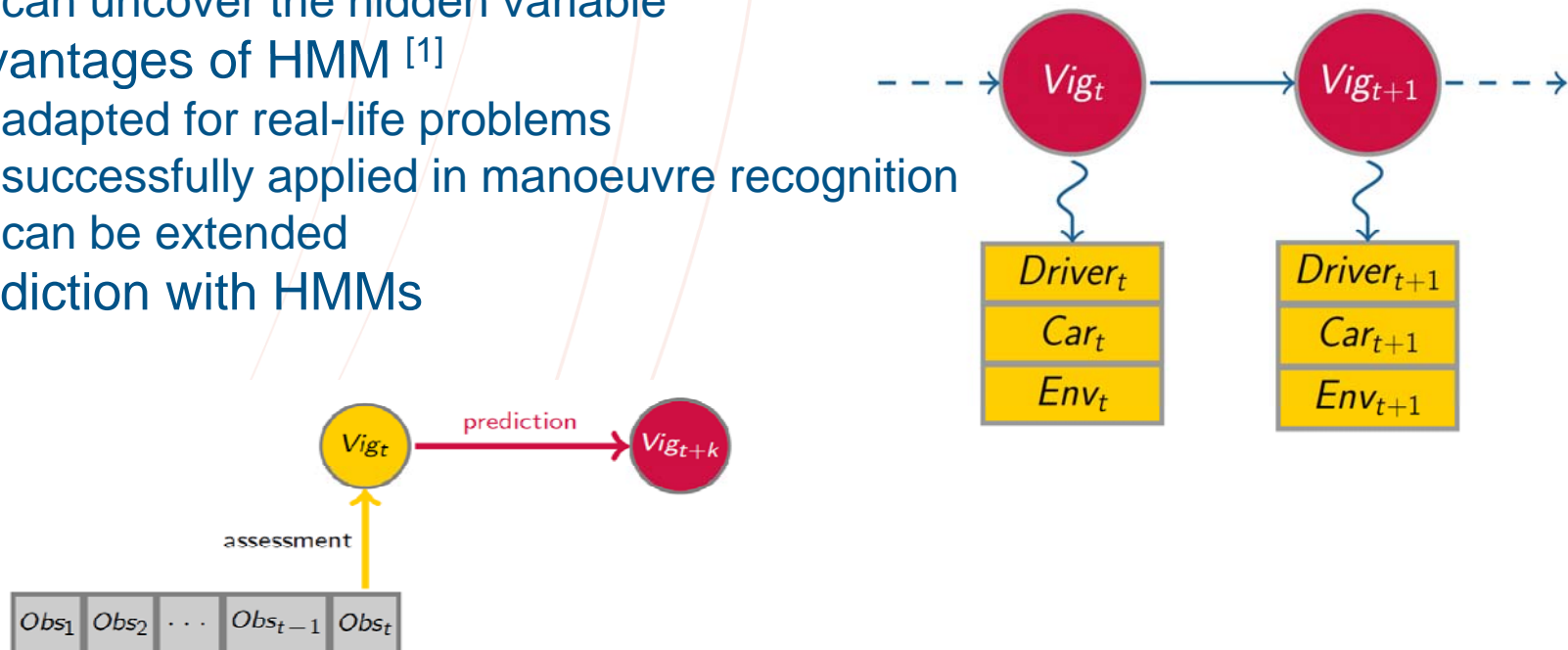


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# HYPOVIGILANCE PREDICTION (2)

- Hidden Markov Models
  - characterised from given observation sequences
  - can uncover the hidden variable
- Advantages of HMM <sup>[1]</sup>
  - adapted for real-life problems
  - successfully applied in manoeuvre recognition
  - can be extended
- Prediction with HMMs



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# CONCLUSION

- Road monotony
  - impairment comparable to fatigue.
  - currently no countermeasure
- Most reliable method to assess vigilance
  - EEG
- Prediction
  - Hidden Markov Model
- Future research
  - implement the proposed methodology in a car
  - development of an in-vehicle device warning drivers at early signs of inattentive driving



## *Contact Details:*

**Grégoire Larue**

Centre for Accident Research & Road Safety

Queensland, Australia

email: [g.larue@qut.edu.au](mailto:g.larue@qut.edu.au)

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