Acceleration level and inability to predict vehicle path increase carsickness symptoms induced by very low frequency lateral movements in real driving conditions

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Congress on motion sickness

July 9th, 2019

In the vertical axis, critical threshold between 0.16 et 0.20Hz, the more important the acceleration, the quicker and severe are the symptoms

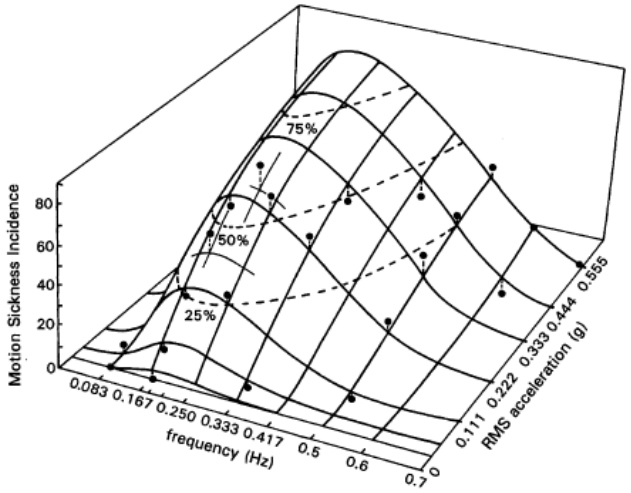

FIG. 1. Motion sickness incidence (%) after 2 h of endured motion versus frequency and acceleration. Each dot represents an observed average over 20 subjects. (Adapted from Ref. 11.)

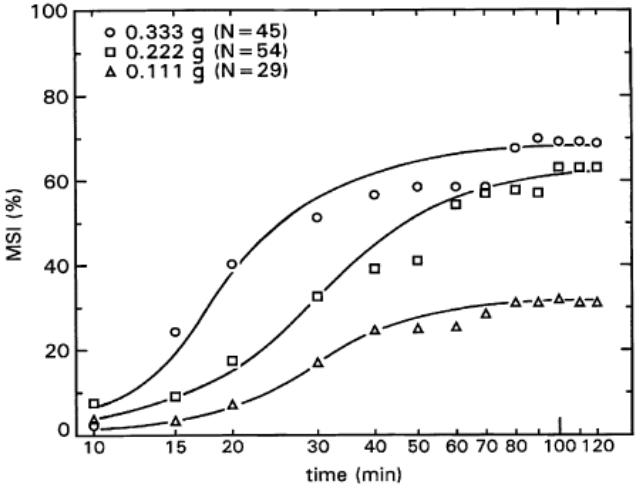

FIG. 2. Motion sickness incidence versus exposure time at one frequency of 0.25 Hz. (Adapted from Ref. 11.)

O'Hanlon & Mc Cauley, 1974

In the vertical axis, critical threshold between 0.16 et 0.20Hz, the more important the acceleration, the quicker and severe are the symptoms

Some works confirmed this for car dynamics in the lateral axis with slalom tests

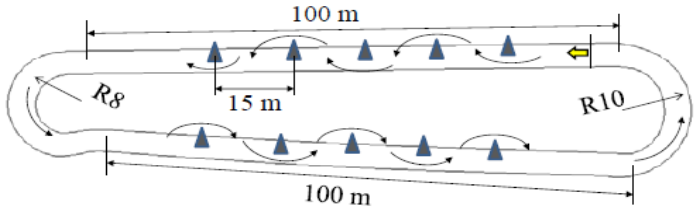

Figure 3. Test track

Wada et al., 2006

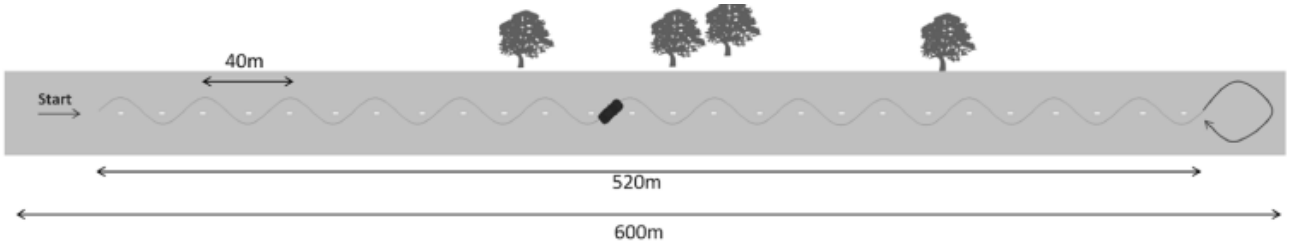

Fig. 1. Schematic of the test track. The vehicle was driven around 26 markings in slalom driving, corresponding to 13 cycles of 40 m. At the ends of the test track there was ample room to do a controlled U-turn. The amplitude of each slalom was 1.5 m measured from the markings to the centre of the car. The maximum angle of yaw as seen from the centre-line was about 20°.

Kuiper et al., 2018

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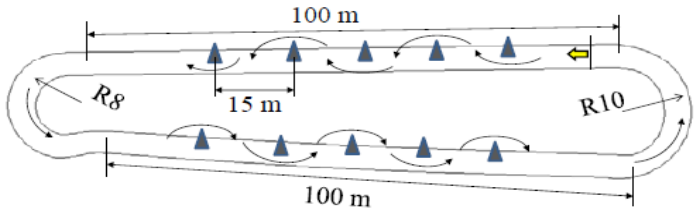

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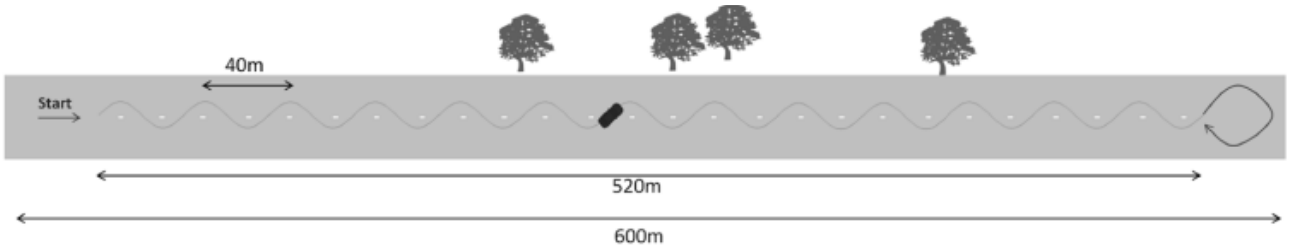

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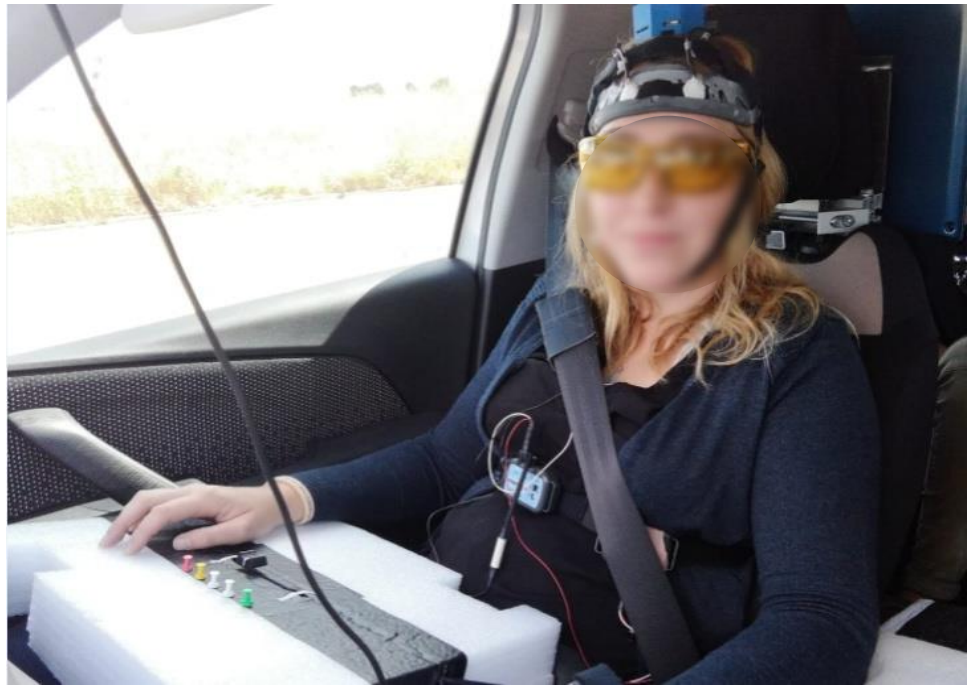
Kuiper et al., 2018

Being unable to anticipate vehicle movements seems to increase motion sickness symptoms

Rolnick & Lubow, 1991

Objectives

Evaluating the impact of the acceleration level and the inability to predict vehicle path on the occurrence of car sickness symptoms, induced by very low frequency lateral movements (0.2Hz) in real driving conditions



Experimental protocol

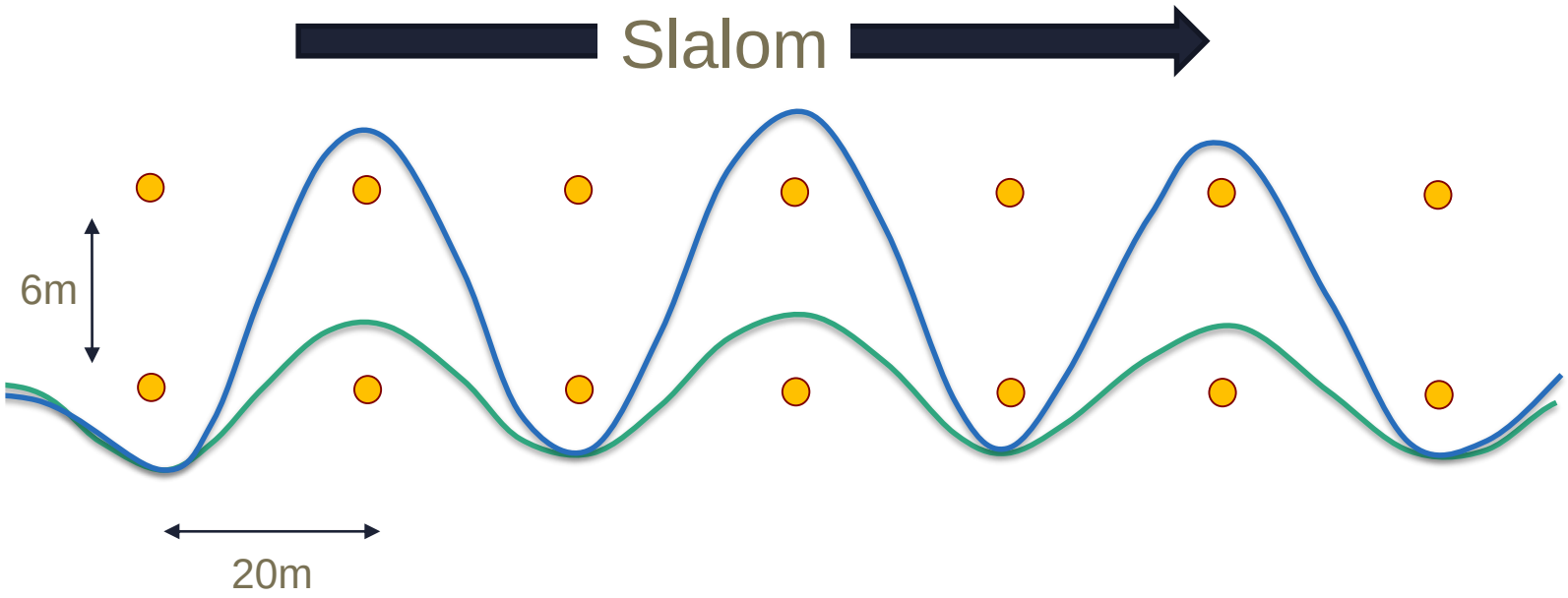
Acceleration level

4 conditions:

Small (3-5m/s²)

Large (8-10m/s²)

Speed : ***35 km/h***



n = 24 participants
(39.3 ± 9.1 yo)

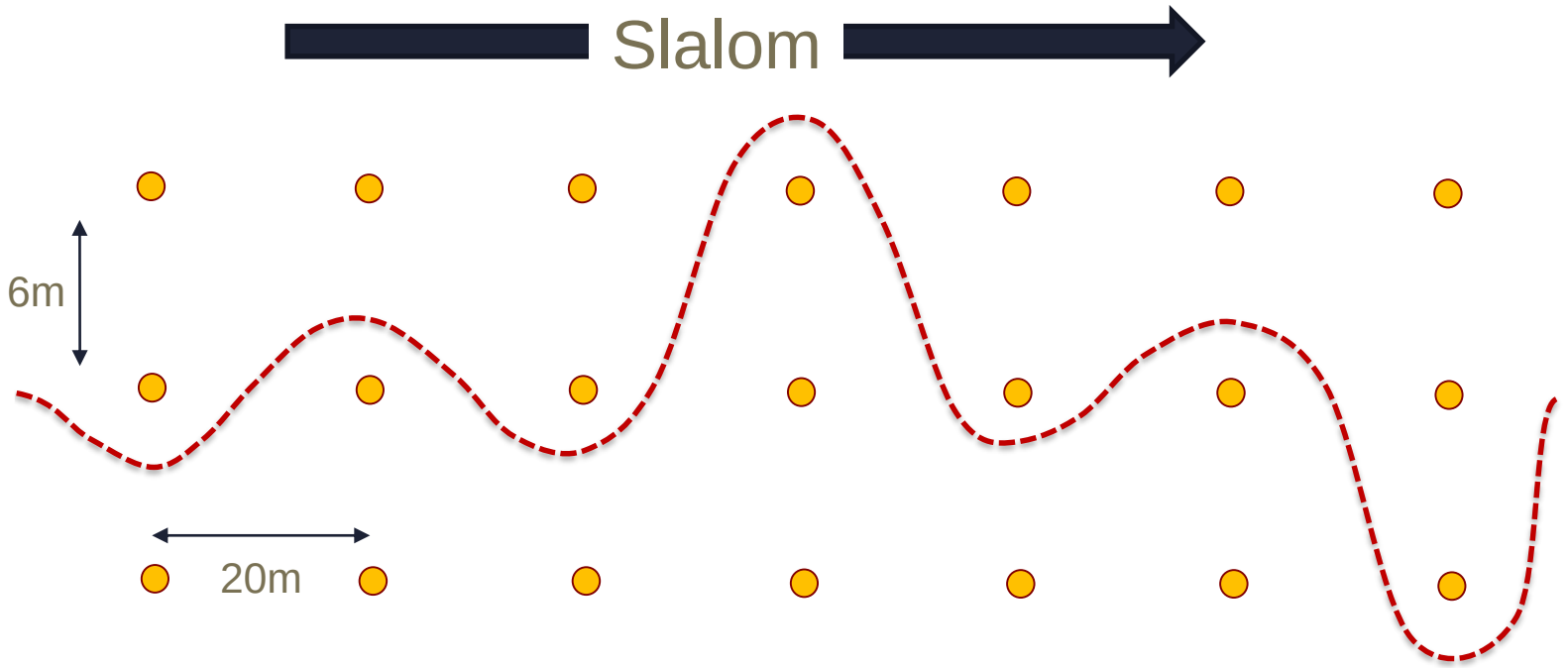
Experimental protocol

Acceleration level
Unpredictability

4 conditions:

- ***Small (3-5m/s²)***
- ***Large (5-10m/s²)***
- ***Unpredictable small***

Speed : ***35 km/h***



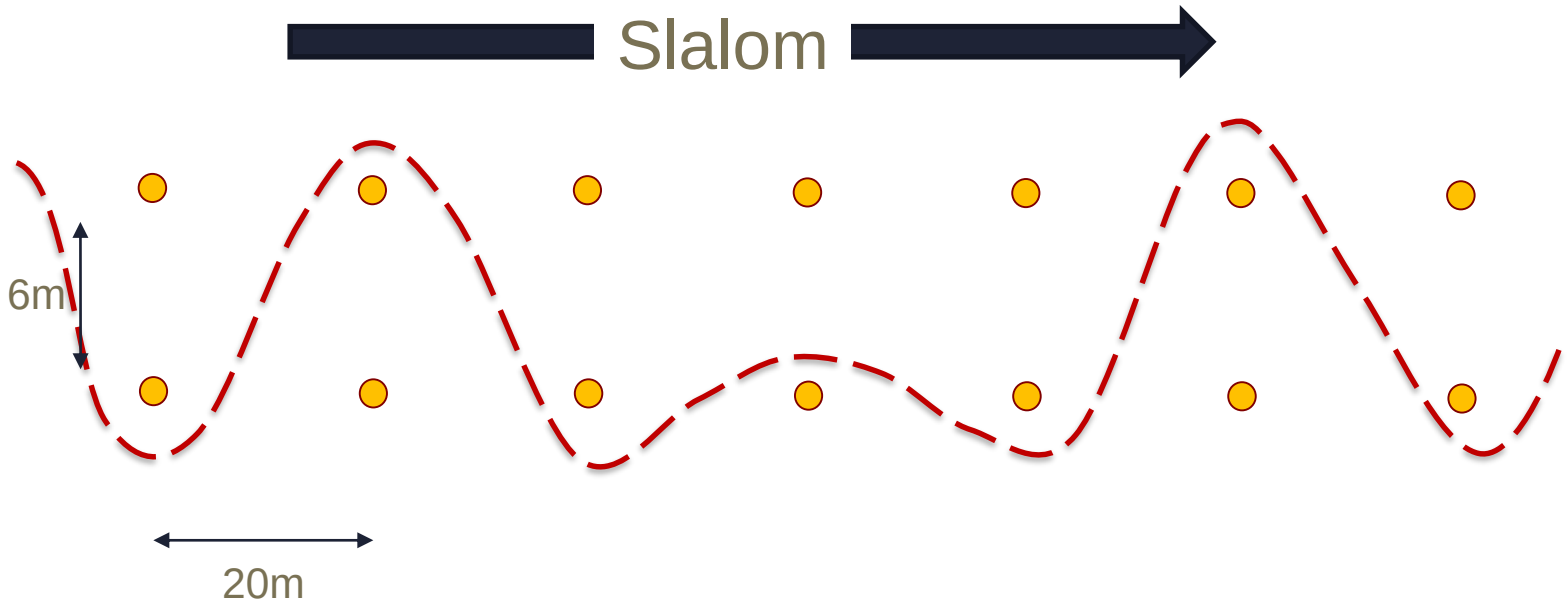
Experimental protocol

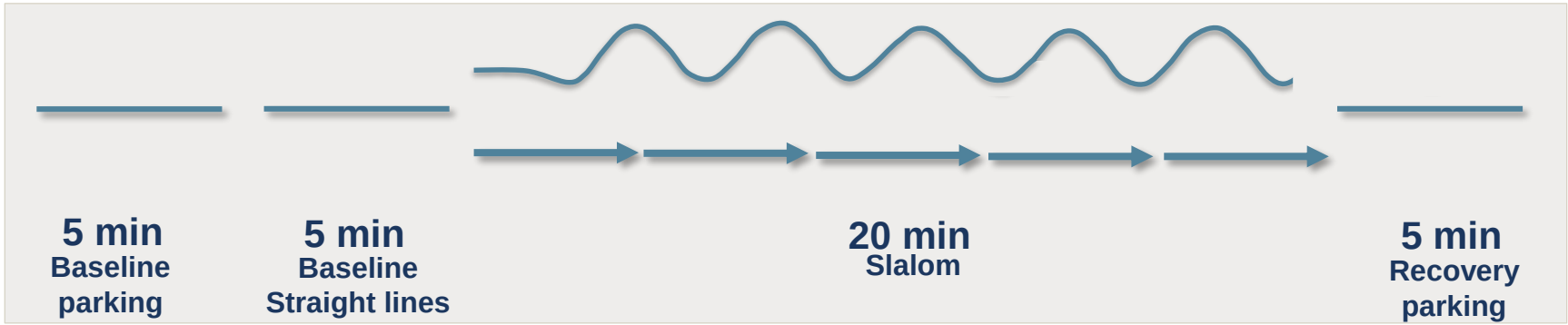
Acceleration level
Unpredictability

4 conditions:

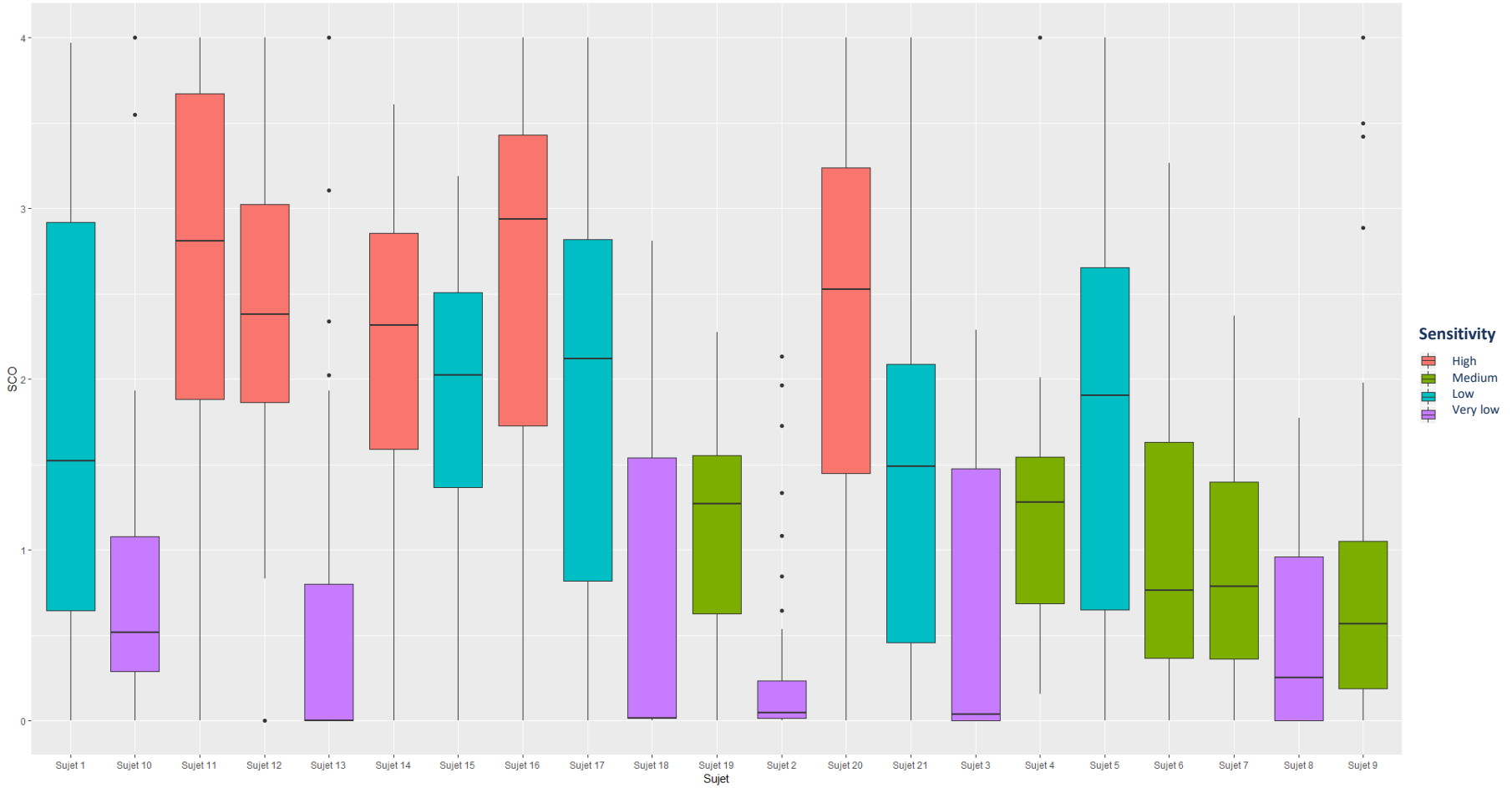
- ***Small (3-5m/s²)***
- ***Large (5-10m/s²)***
- ***Unpredictable small***
- ***Unpredictable large***

Speed : ***35 km/h***





Car sickness ratings

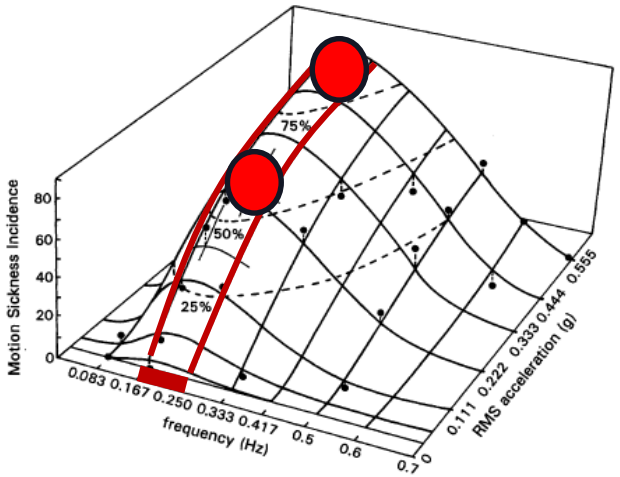


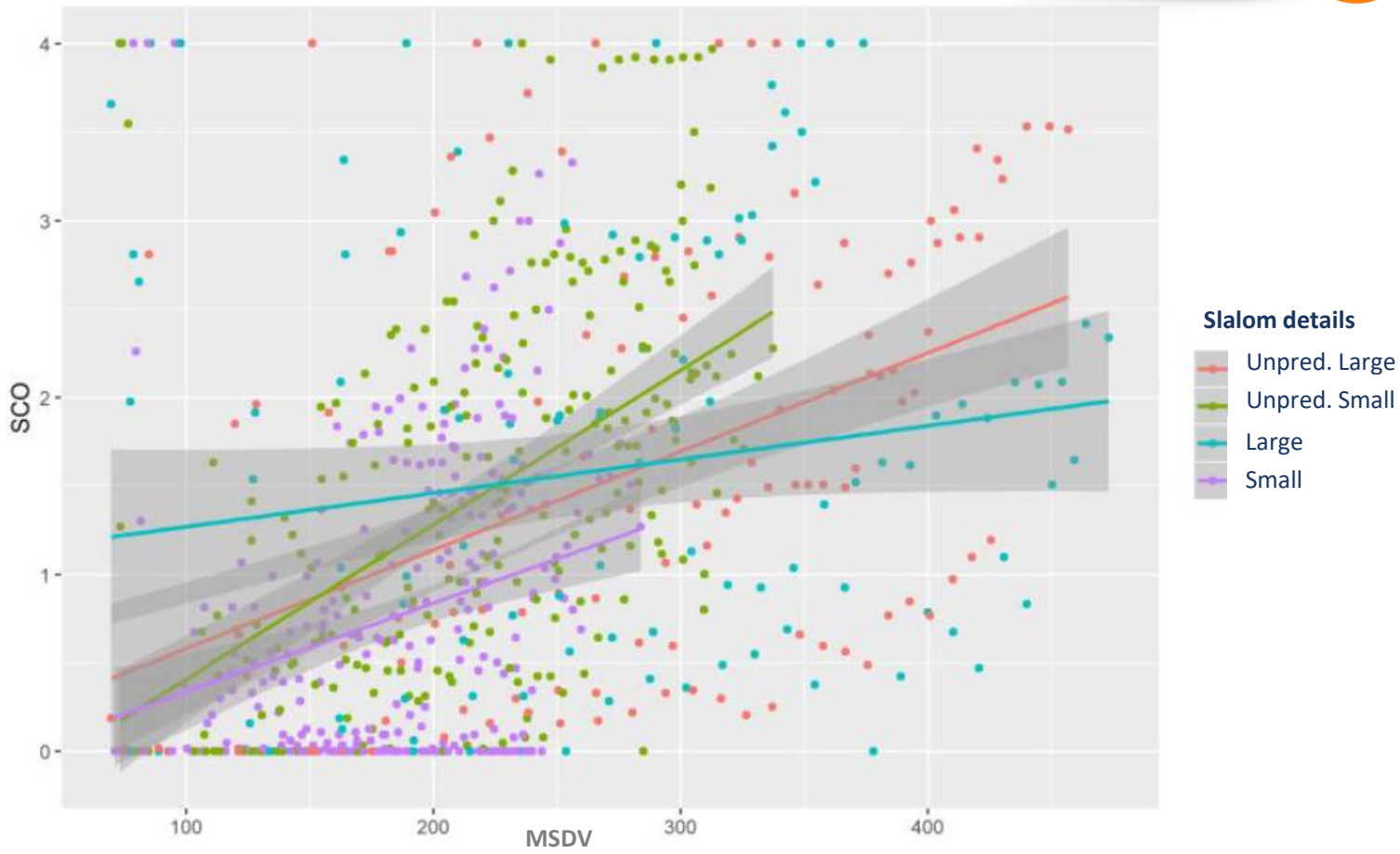
Everyone became sick to some extent in 20min >> 0.2Hz lateral movements are noxious in real driving conditions

Car sickness ratings / vehicle dynamics

MSDV[2]: $f(a(t)) = \sqrt{\int (a(t)^2 \times dt)}$

a= acceleration; t=exposure period





Looking for relation between subjective score and Motion Sickness Dose Value (MSDV: indicator of the vehicle dynamics based on lateral acceleration only)

Car sickness ratings / vehicle dynamics

MSDV²: $f(a(t)) = \sqrt{\int (a(t)^2 \times dt)}$

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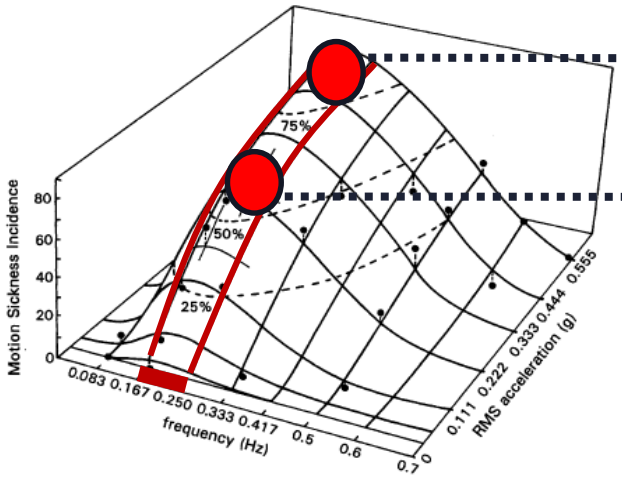

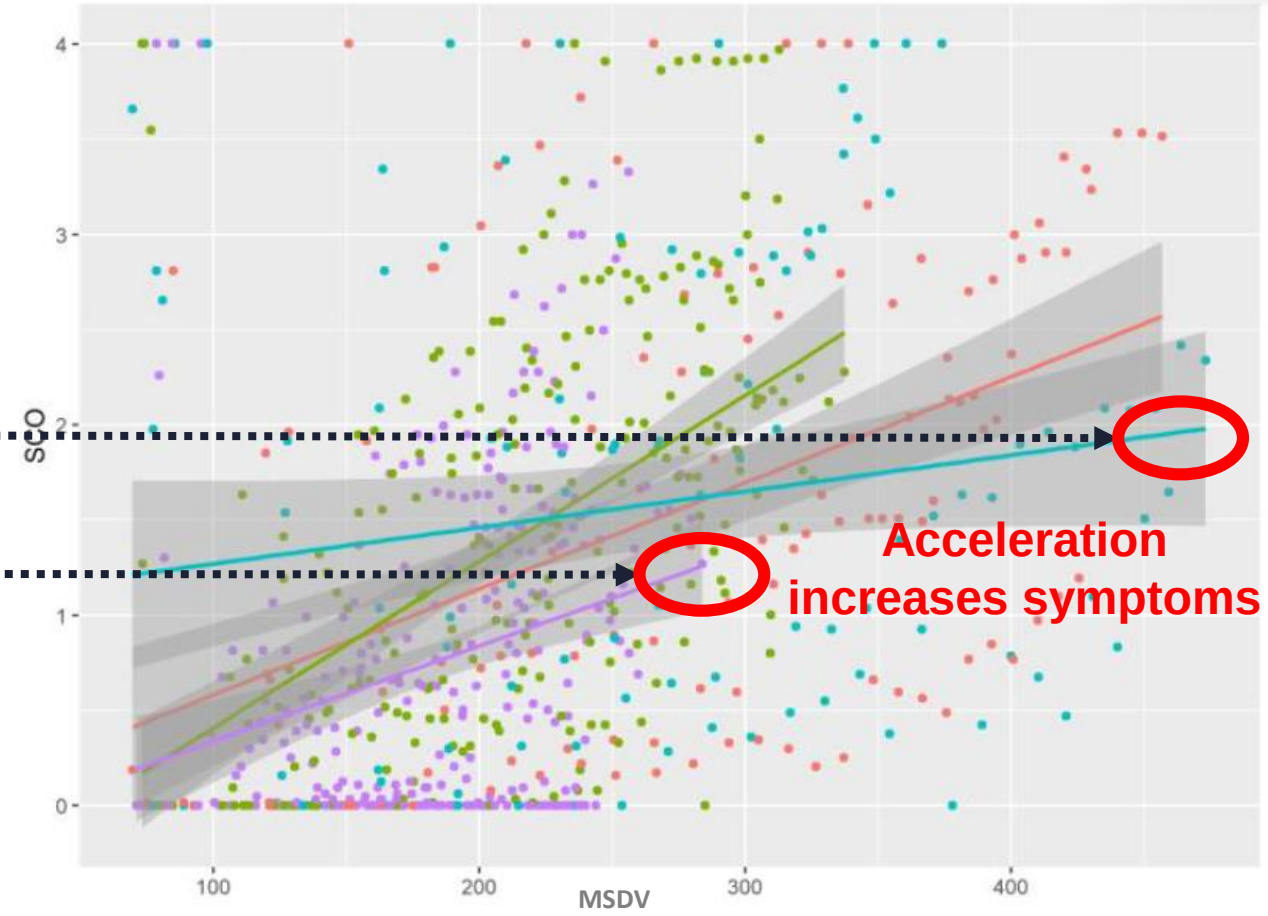

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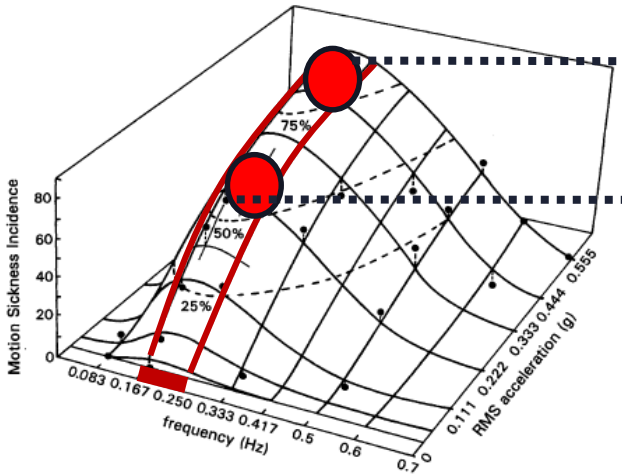

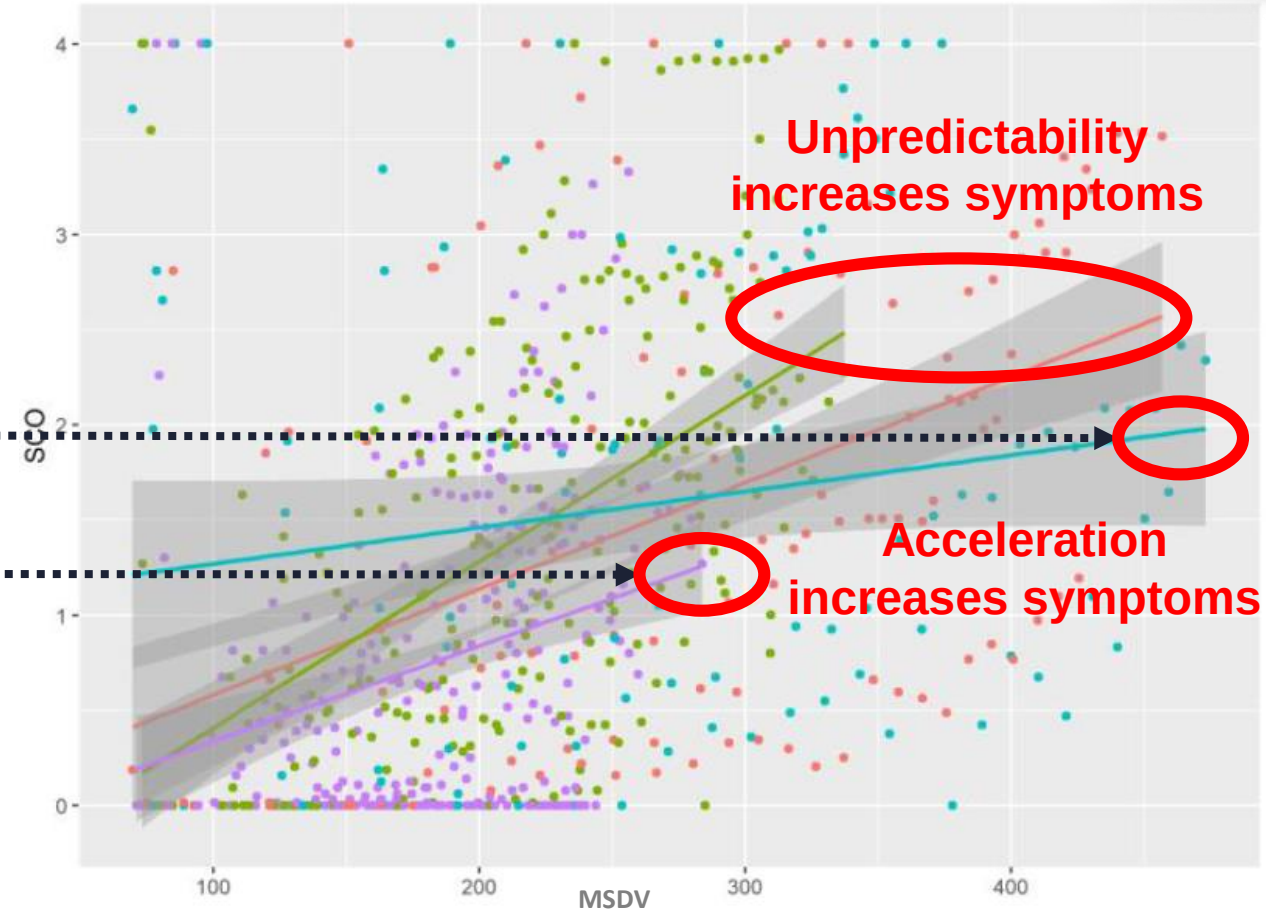

In transportation, movements are not regular but include important sequences of acceleration/braking or unexpected turns

Conclusion and perspectives

✓ **Validated methodology to induce carsickness symptoms**

→ Increase of carsickness ratings

✓ **Acceleration level increases carsickness symptoms**

→ The higher, the worse

✓ **Unpredictability of vehicle path increases carsickness symptoms without any visually induced sensory conflict**

→ Participants were asked to look forward, without being engaged in any other task

Car manufacturers and suppliers should focus on the smoothness of path control and give ways to anticipate the upcoming path

Trolls won’t get sick anymore! Thank you for your attention!

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