Distinguishing carsickness sensitivity based on passengers’ posture analysis according to vehicle dynamics

Clément Bougard¹,², Eléonore Henry¹,², Naman Negi³, Christophe Bourdin², Lionel Bringoux²

¹ Groupe PSA, Centre Technique de Vélizy, Vélizy-Villacoublay, France
² Aix Marseille Univ, CNRS, ISM, Marseille, France
³ Telecom Paris, Palaiseau, France
Motion sickness: Frequency and Acceleration levels

In laboratory conditions, a critical threshold (0.16 - 0.20Hz) has been identified in the vertical axis.

The higher the acceleration level, the faster and more severe 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)

O’Hanlon & Mc Cauley, 1974

**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-vehicle tests confirmed the deleterious effects of these low-frequency movements in the lateral axis, using different configurations.

Nonetheless, only one acceleration level (2-3 m/s²) has been tested yet, using regular slaloms.
Motion sickness: Vehicle path prediction

Being unable to predict the vehicle path increases car sickness symptoms occurrence

The driver does not have the same posture as the passenger

No information available yet on the movements of the passenger’ chest, nor on driver’ movements
Objectives

Evaluating the impact of the acceleration level and the unpredictability of vehicle path on passenger’ carsickness sensitivity

We hypothesize that passenger’ posture should reflect carsickness sensitivity:
- Their posture will differ from drivers’ posture
- This difference may be stressed out by the acceleration level of the car and their incapacity to predict vehicle path
**Procedure**

4 conditions

Speed: 35 km/h

**Acceleration level**

- **Large (5-6 m/s²)**
- **Small (2-3 m/s²)**

**Test session**

- 300 m
- 20 m
- 5 min
- 20 min

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**Unpredictable large**

- Incapacity to predict vehicle path

**Unpredictable small**
# Measurements

## Participants
- 24 participants
  - 12 Small / Unpredictable Small
  - 12 Large / Unpredictable Large
- 12 men / 12 women
  - 39.3 ± 9 yo

## Subjective ratings
1. No symptoms
2. Mild symptoms
3. Mild symptoms without nausea
4. Mild nausea
5. Mild to moderate nausea (STOP)

## Posture analysis
- Accelerometer fixed on the passenger’ chest
- Accelerometer fixed on the driver’ chest

## Dynamics calculation
MSDV: \[ f(\mathbf{a}(t)) = \sqrt{\int (\mathbf{a}(t)^2 \times dt)} \]
a = acceleration; \( t \) = time of exposure

## Vehicule measurements
- C4 Picasso
- Longitudinal and lateral acceleration
- Speed
- Steering wheel angle
Low frequency (0.17 - 0.2Hz) lateral movements are critical in real driving conditions. Every participant became sick during the test to some extent, mostly in the large slaloms. Lower subjective ratings in recovery for small slaloms.
Subjective ratings / vehicle dynamics

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

- **a** = acceleration; **t** = time of exposure

**Large inter-individual variability**

Some participants rapidly scored at the maximum level (large/unpredictable large)
Subjective ratings / vehicle dynamics

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

a = acceleration; t = time of exposure

Influence of the acceleration level

Acceleration level increases symptoms
Subjective ratings / vehicle dynamics

MSDV: \[ f(\ a(t)\ ) = \sqrt{\int (a(t)^2 \times dt)} \]
a = acceleration; t = time of exposure

Higher scores in unpredictable slaloms

Unpredictable Small, also a slight increase in MSDV, but not the case for Unpredictable Large

Incapacity to predict vehicle path increases symptoms
Car, driver, and passenger movements

Drivers, who rarely feel sick, have limited movements (close to the vehicle movements quantity). In contrast, passengers have important movements in every condition (postural instability?)
Passenger’ movements (chest) / carsickness sensitivity

Introduction

Materials & Methods

Results & Discussion

Conclusion

Small

Unpredict.
Small

Large

Unpredict.
Large

Subjective ratings
Conclusion & perspectives

✓ Influence of the acceleration level
  - Large slaloms induced higher symptoms

✓ Being able to predict car movements limits symptoms severity
  - Driver was not affected
  - Driver’ movements were limited regarding passenger’ movements
  - Unpredictable slaloms induced higher carsickness ratings

✓ Symptoms gravity does not seem to be linked to movement quantity (chest)

✓ Our results suggest the influence of further criteria:
  - Head movements (on going analysis)
  - Delay between car and passenger movement
  - Mental stress, anxiety
Thank you, any question?

clement.bougard@mpsa.com