

Automotive Connection 2019

The seat effects on the neuromuscular fatigue during long duration driving



RESEARCH, INNOVATIONS, AND ADVANCED ENGINEERING DEPARTMENT

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INNOVATION : STAKES OF TOMORROW CARS

EVOLUTION OF USES AND NEEDS



INNOVATION STRATEGIC PRIORITIES



CLEAN TECHNOLOGIES



SMART VEHICLE



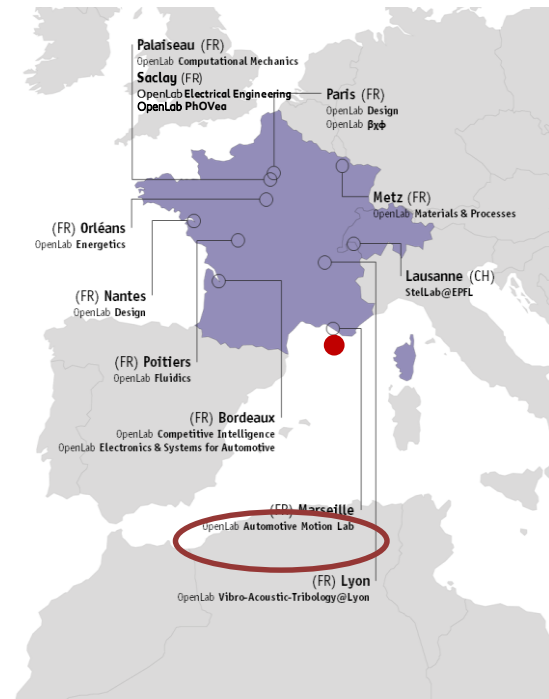
ATTRACTIVENESS



NETWORK STELLAB



Network International

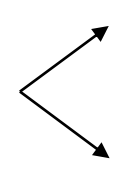




Long duration driving



Prolonged posture



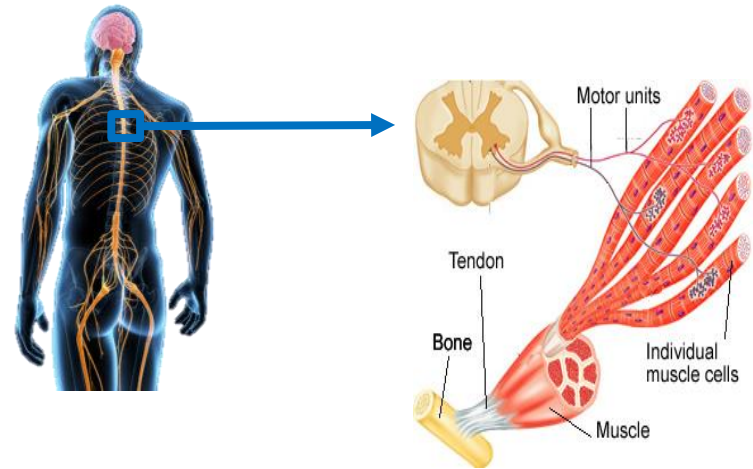
Pain

Neuromuscular fatigue

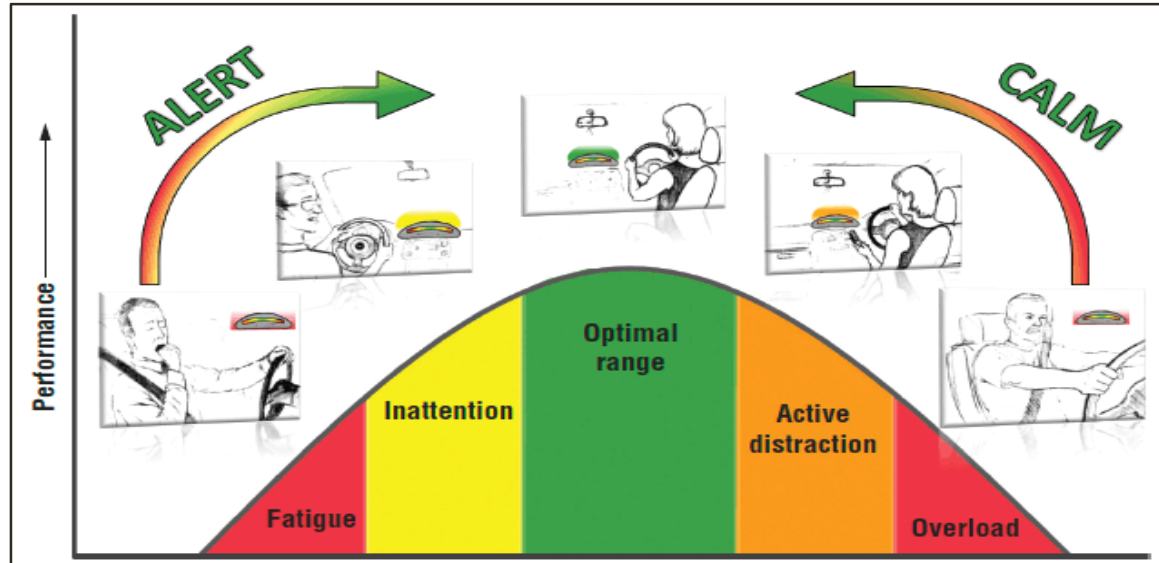
Concept of Neuromuscular fatigue

"Any reduction of the subject's capacity to produce a force / speed / power, whether the task is maintained or not, and reversible during a recovery period".

(Barry & Enoka, 2007)



Pain & Neuromuscular fatigue → Mental workload management



(Recarte & Nunes, 2003 ; Borghini et al., 2014)

→ Major role of car seats design for better comfort/efficiency

OBJECTIVES

For the same car configuration (filtration, posture) and for long duration driving condition :

- Assess the effect of **three different seats**

Citroën C4-Picasso

Soft (fabric)



Peugeot 308

Firm (leather)



Suspended

new technology (fabric)



- Define new seat design which could reduce the neuromuscular fatigue

EXPERIMENTAL PROTOCOLS

EXPERIMENT 1

Number of subject=20

308



C4 Picasso



Static simulator



- Participants adjust themselves their seat before the driving session

- Automatic gearbox

- 3 hours of driving without break time

EXPERIMENT 2

Number of subject=20

308



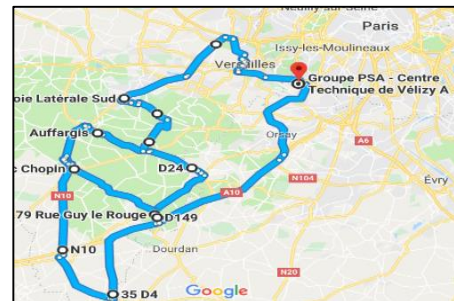
C4 Picasso



« SUSPENDED »



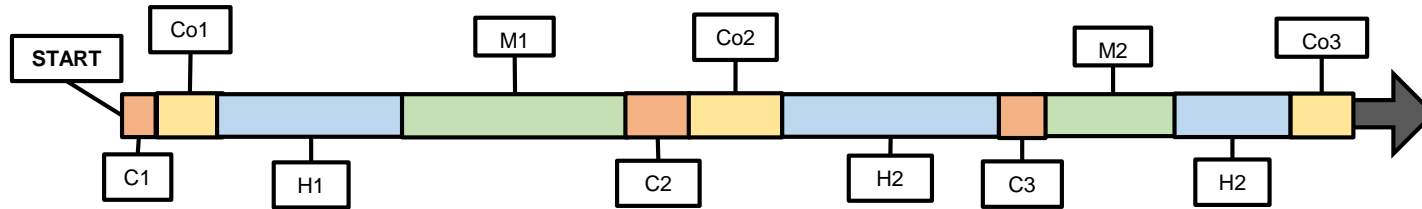
Real driving condition



- Different types of roads (highway, city, mountain and departmental roads)

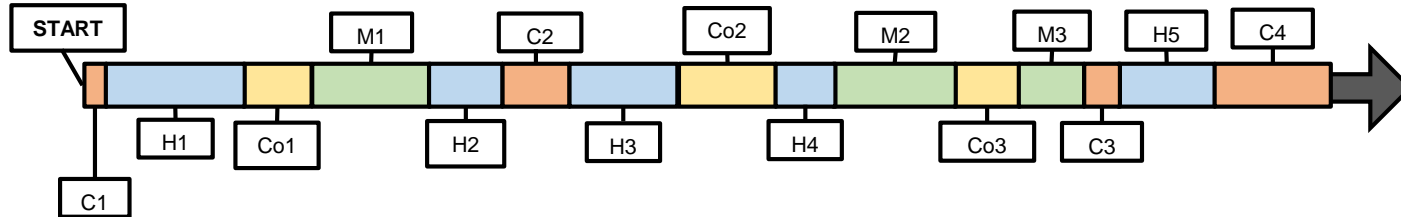
EXPERIMENTAL PROTOCOLS – ROAD SECTORS

EXPERIMENT 1



- Ci = City roads
- H = Highway roads
- Co = Country roads
- M = Mountain roads

EXPERIMENT 2



MATERIALS AND METHODS 1/2 : ELECTROMYOGRAPHY ANALYSIS

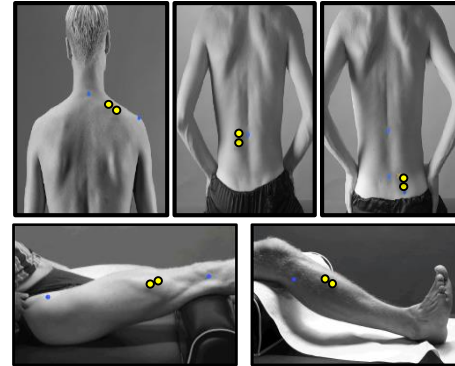
During driving session

Electromyographic recording of eight muscles involved during driving task:

- Trapezius descendant (bilaterally)
- Erector spinae longissimus (bilaterally)
- Multifidus (billaterally)
- Tibialis anterior
- Vastus Lateralis

(McGill et al., 2000 ; Hostens & Ramon, 2005)

EMG electrodes placement



Analysis :

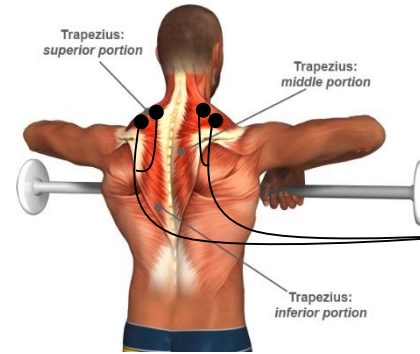
- Muscles RMS according to time and road sectors

Before and after driving session

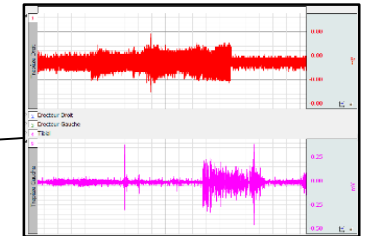
Endurance static test: Maintain a weight bar at pectoral level as long as possible. Recording of trapezius muscular activity.

Analysis :

- Time limit
- Trapezius RMS-EMG (root mean square)

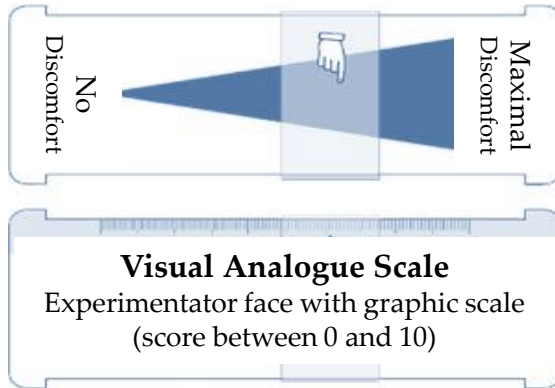


EMG signal



During driving session

General discomfort assessment

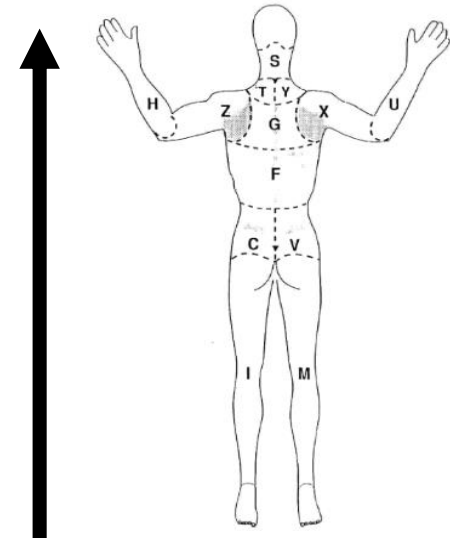


→ Every 20 minutes during driving session

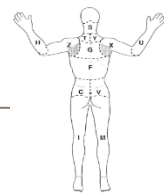
Discomfort scores for each body part

100 = max

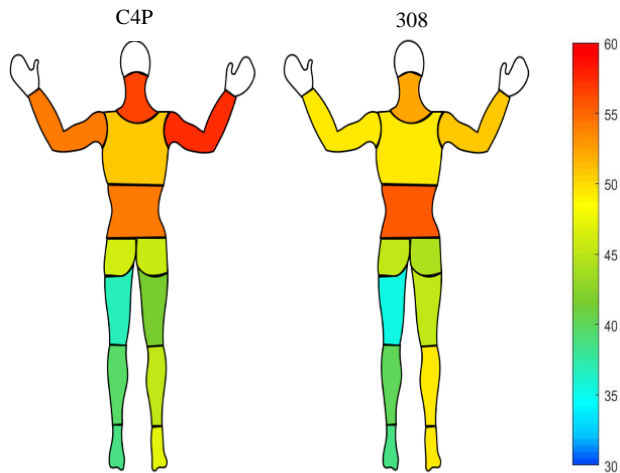
0 = min



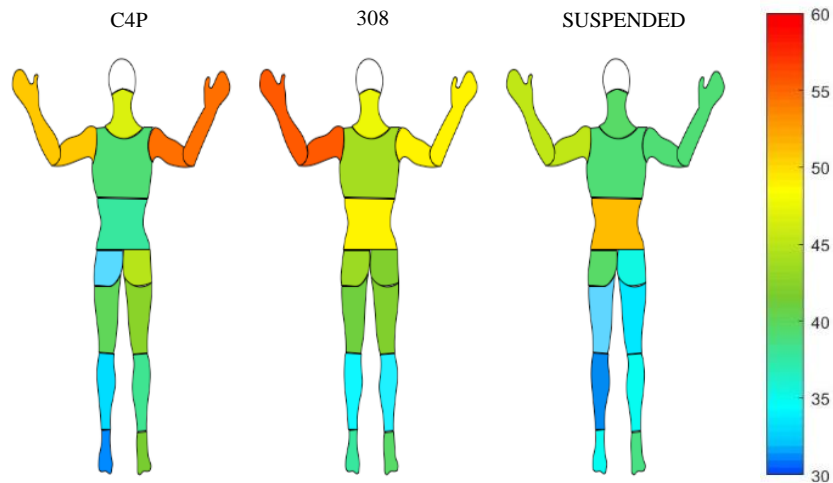
RESULTS 2/5 : BODY PART DISCOMFORT LEVEL



EXPERIMENT 1 – static simulator



EXPERIMENT 2 – real driving condition



✓ Real driving condition induces lower level of discomfort compared to static simulator

CONCLUSION

- ✓ Long duration driving highlighted different neuromuscular fatigue profiles between the seats with few differences between static simulator and real condition due to vibrations, accelerations etc...
- ✓ The softer features of C4P seat lead to an absence of compensation strategy during the driving task, which, in turn, induce higher neuromuscular fatigue. This is confirmed by a greater fall of endurance time.
- ✓ Suspended seat seems to be promising as we found also compensation strategy as for the 308 but with less muscular activity leading to a better tolerance to neuromuscular fatigue as confirmed by the lack of difference in endurance time test between before and after conditions
- ✓ Finally, subject's perception of seat's comfort is not correlated to the level of neuromuscular fatigue. For example : the subject could perceive C4P as more comfortable but it is not necessary correlated to the level of neuromuscular fatigue.