Results of the Study on Transition for level 3 Automated Driving system

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Objectives of the Study

1. To study transition from Level 3 Automated Driving system to manual driving after a request to intervene.
   
   (1) Measures of takeover time and driving recovery time after a request to intervene.
   
   (2) Evaluation of the efficiency of the manual driving after the takeover

2. To test the efficiency of various HMI (not presented here) on the takeover time and manual driving.

Elsa Yousfi (2018). *Situation awareness and driving performance subsequent to manual takeover*. PhD manuscript in preparation

Experimental conditions

Scenarios made with the software SCANeR studio

The other task was performed with a touch pad on the dashboard (Mah Jong game)

Simulator of Vedecom

Experimental conditions

Experiment carried out during the first semester 2017

Participants:
N = 70 including 35 women.

Inclusion criteria:
1) Under 45 years old
2) Driver’s license since at least 3 years
3) To drive at least once a week.

Description of participants:
Mean age = 32 years
Driving experience = 13 years (Mean)
Average distance driven by year = 13914,25 km (Mean)

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Experimental conditions

Highway 2 x 3 lanes
Speed = 110 km/h

2 conditions:
Group1 « TTB4 »: TTB = 4 s ↔ 122 m from the obstacle
Group2 « TTB8 »: TTB = 8 s ↔ 244 m from the obstacle
TTB = Total Time Budget

Vehicles overtaking the participant’s car:

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Experimental conditions

For each participant,

Psychological tests

Training

Experiment with 3 trials:
3 counterbalanced trials with a different HMI each time

Psychological tests and interview

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Take-Over Time / Driving recovery Time

In case of a critical event after the driving recovery time

Driving recovery time = take-over time + intervention time (with success)

Safe situation, if Driving recovery Time < Total time budget
In case of a critical event before the end of the driving recovery time

- if Take-over time < Total time budget < Driving recovery time
- if Total time budget < Take-over time < Driving recovery time

Not a safe situation

Driving recovery time = take-over time + intervention time (with success)
Results

Experiment with 2 groups to test the total time budget (4s / 8s) in critical situations.

![Number of collisions graph]

- **4 seconds**: 25 collisions
- **8 seconds**: 1 collision

\[
\begin{align*}
n &= 98 \text{ (33+32+33)} & n &= 98 \text{ (33+32+33)} \\
\text{Mean TOT} &= 2.38 \pm 0.82 & \text{Max TOT} &= 5.05 \\
\text{Mean TOT} &= 2.84 \pm 0.90 & \text{Max TOT} &= 6.6 \\
\end{align*}
\]

High number of collisions when the total time budget is 4 seconds: **26%** (25/98).

The driving recovery time includes:

1) The takeover time

2) Intervention time: Adapted actions if needed

Each time depends on various factors that induce a variability.

That implies to work with a range of values and needs to take into account the drivers who will not takeover in time.
• The French study (speed = 110 km/h) shows that:
  • The shorter the total time budget, the shorter the mean take-over time. However % collisions + near collisions increases
  • 26% of collisions when Total Time Budget is 4s
  • 1% of collisions when Total Time Budget is 8s

• If a critical situation occurs before the end of the driving recovery time, it cannot be well tackled by the dynamic driving intervention of the driver.

• Driving Recovery Time shall be taken into account in the regulation, instead of Take-Over Time.

• Need to take into account the drivers who will not takeover in time.