ATTENTIONAL DEMANDS OF USING AN APPLICATION FOR REAL-TIME TRAFFIC INFORMATION FEEDBACK IN ROAD OPERATORS' VEHICLES

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C-ROADS
FRANCE
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DDI 2022
GOTHENBURG

INTRODUCTION (1/2)

Context

- European projects for testing and implementing Cooperative Intelligent Transport Systems (C-ITS services) to alert road users in real time

- Deployment of an application in road operators' vehicles

- Distraction issue raised by study of acceptability among French road operators agencies
(SCOOP project; Chahir et al., 2019)

Source : https://www.c-roads.eu/platform.html

INTRODUCTION (2/2)

Screen 1
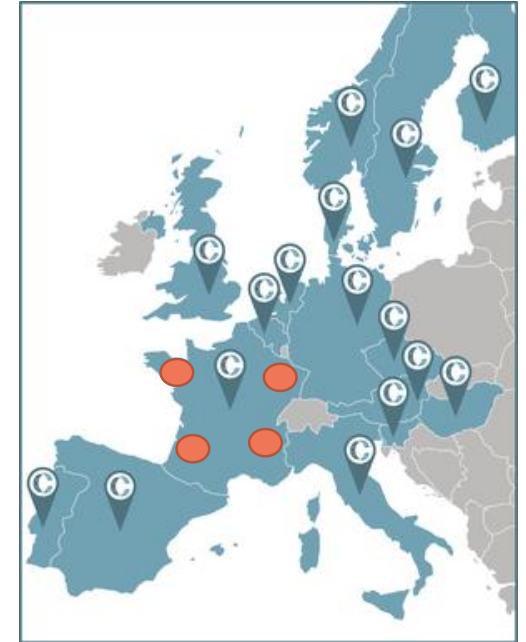
Study objective

- Assessment of attentional demand among French road operators during visual-manual interaction tasks with the application
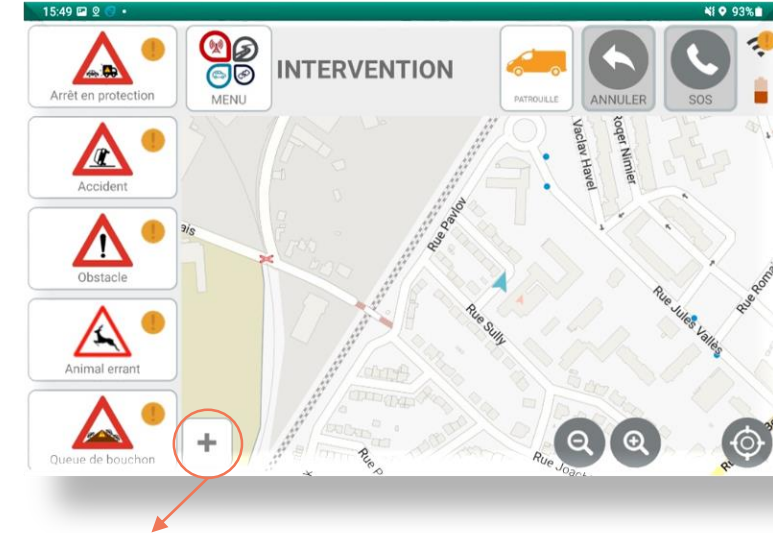
Study's principle

- In-vehicle systems assessment methodologies (Strayer et al., 2019)
- Indicators of subjective, temporal, visual and cognitive demands (Strayer et al., 2019)

Screen 2

Road operators' task to report an event

- Three levels of visual-manual interaction complexity
  - Screen 1: 1 press
  - Screen 2 – Top: 2 presses
  - Screen 2 – Bottom: 1 press, scrolling plus 1 press
- Not requiring more than 3 control actions (Campbell et al., 1998, 2012)

METHODOLOGY (1/5)

Participants

- Employees of one of the French public road operators' agencies (DIR Ouest)
- 20 participants (all males) recruited from 3 different professional groups
  - Difference in their knowledge of the C-ITS services
- 18 participants completed the whole experiment

Driving route

- Two-lane dual carriageway (110 km/h)

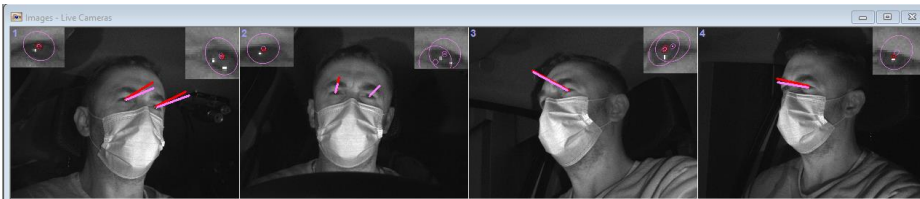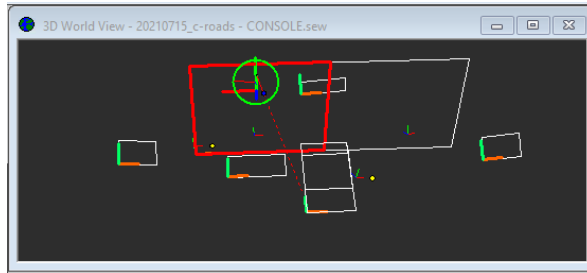
Siège de la DIR

SIR : service d'ingénierie routière

CIGT : centre d'ingénierie et de gestion du trafic

District

CEI : Centre d'entretien et d'intervention

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Equipment

Mental workload scale (Reimer at al., 2013)

Eye-tracker

Cameras

Detection-Response Task kit

Instrumented Vehicle

smarteye

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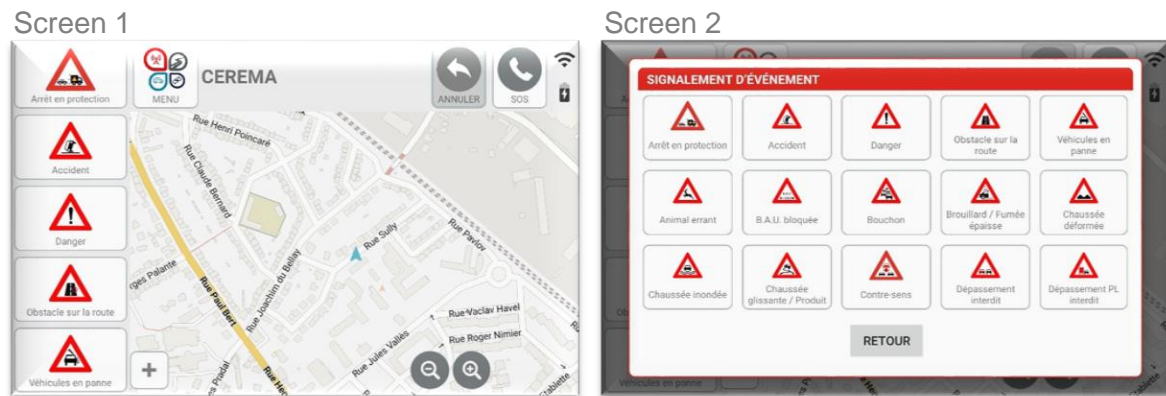Fraternité*

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RED Scientific
HUMAN FACTORS RESEARCH & TOOLS

METHODOLOGY (3/5)

Comparison of the attentional demand of different secondary tasks

SCOOP application visual-manual tasks (3 levels)

- Screen 1: 1 press
- Screen 2 – Top: 2 presses
- Screen 2 – Bottom: 1 press, scrolling plus 1 press

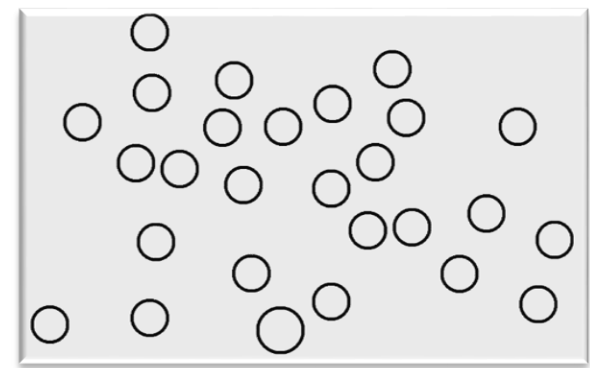Screen 1

Screen 2

Manual radio tuning task (AAM, 2006)

- « acceptable » task

High demands « artificial » tasks (Strayer et al., 2019)

- High visual demand (Surrogate reference task - SuRT)

- High cognitive demand (2-back task)

Stimulus	5	3	7	0	2	…
Response	silence	silence	5	3	7	…

Benchmark

References

METHODOLOGY (4/5)

Procedure

Group 1
10 participants

Direction 1 | Direction 2

Vehicle fam. | Just driving + Driving with DRT ❶ | Stop - WS / stop

Tasks fam. ❷ | Radio or reference Task (3 trials) | Application Task (4 trials) | Stop - WS

Tasks fam. ❸ | Radio or reference Task (3 trials) | Application Task (4 trials) | Stop - WS / random

Tasks fam. ❹ | Radio or reference Task (3 trials) | Application Task (4 trials) | Stop - WS

Driving with DRT + Just driving ❺ | Stop - WS

Group 2
8 participants

Direction 1 | Direction 2

Vehicle fam. | Just driving + Driving with DRT ❶ | Stop - WS / stop

Tasks fam. ❷ | Application Task (4 trials) | Radio or reference Task (3 trials) | Stop - WS

Tasks fam. ❸ | Application Task (4 trials) | Radio or reference Task (3 trials) | Stop - WS / random

Tasks fam. ❹ | Application Task (4 trials) | Radio or reference Task (3 trials) | Stop - WS

Driving with DRT + Just driving ❺ | Stop - WS

Attentional demands of using an application for real-time traffic information feedback in road operators' vehicles

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METHODOLOGY (5/5)

Calculation of 4 standardised scores for application and radio tasks (Strayer et al., 2019)

Subjective demand
perceived mental workload (Reimer et al., 2013)

$$\frac{Application\ or\ radio\ task\ -\ Driving\ with\ DRT\ task}{\frac{2\text{-back task + SuRT task}}{2}\ -\ Driving\ with\ DRT\ task}$$

Temporal demand
time to complete the task (The Observer, Noldus IT)

$$\frac{Application\ or\ radio\ task}{24}$$

Visual demand
% of time with eyes on the road ahead (eye-tracker, SmartEye)

$$\frac{Driving\ with\ DRT\ task\ -\ Application\ or\ radio\ task}{Driving\ with\ DRT\ task\ -\ SuRT\ task}$$

Cognitive demand
reaction time to a tactile stimulus (Red Scientific, USA)

$$\frac{Application\ or\ radio\ task\ -\ Driving\ with\ DRT\ task}{2\text{-back Task}\ -\ Driving\ with\ DRT\ task}$$
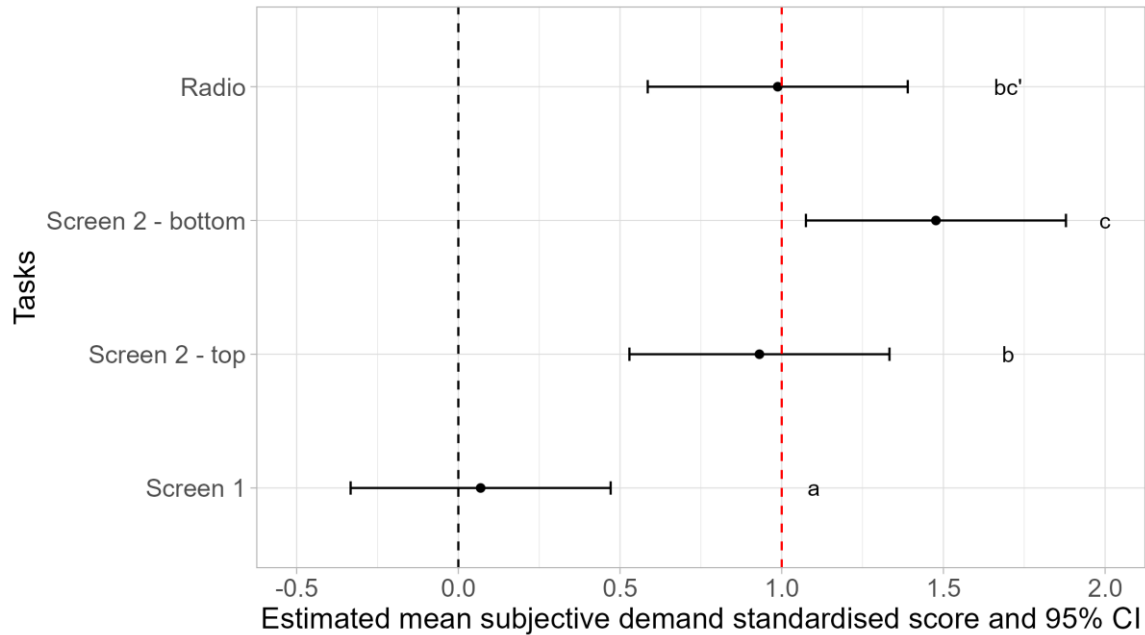
Statistical analysis

- Comparison of 3 different mixed effect models (**Task Type** ; Professional Group ; Task Type x Professional Group)

- Most likely model : **Task Type** effect (Screen 1 **|** Screen 2 – top **|** Screen 2 – bottom **|** Radio)
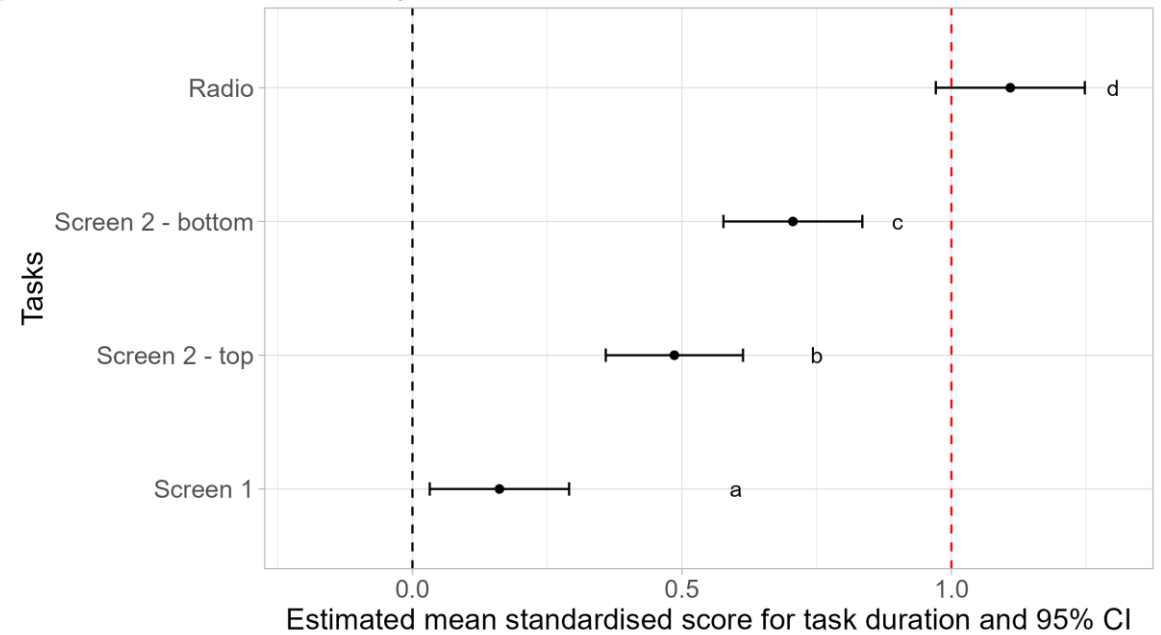
RESULTS (1/2)

Subjective demand
(n = 18; Task type : $F_{(3, 51)} = 16.45$, $p < 0.001$)

Temporal demand
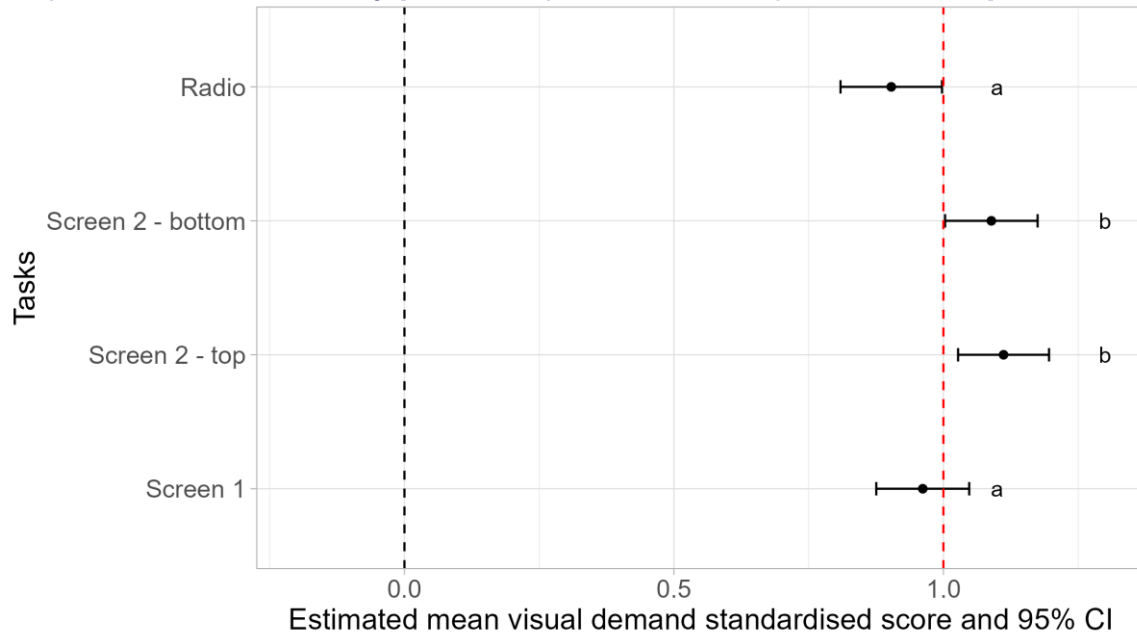(n = 18; Task type : $F_{(3, 232.51)} = 73.07$, $p < 0.001$)

↗ subjective demand & temporal demand with complexity of the interaction with the application

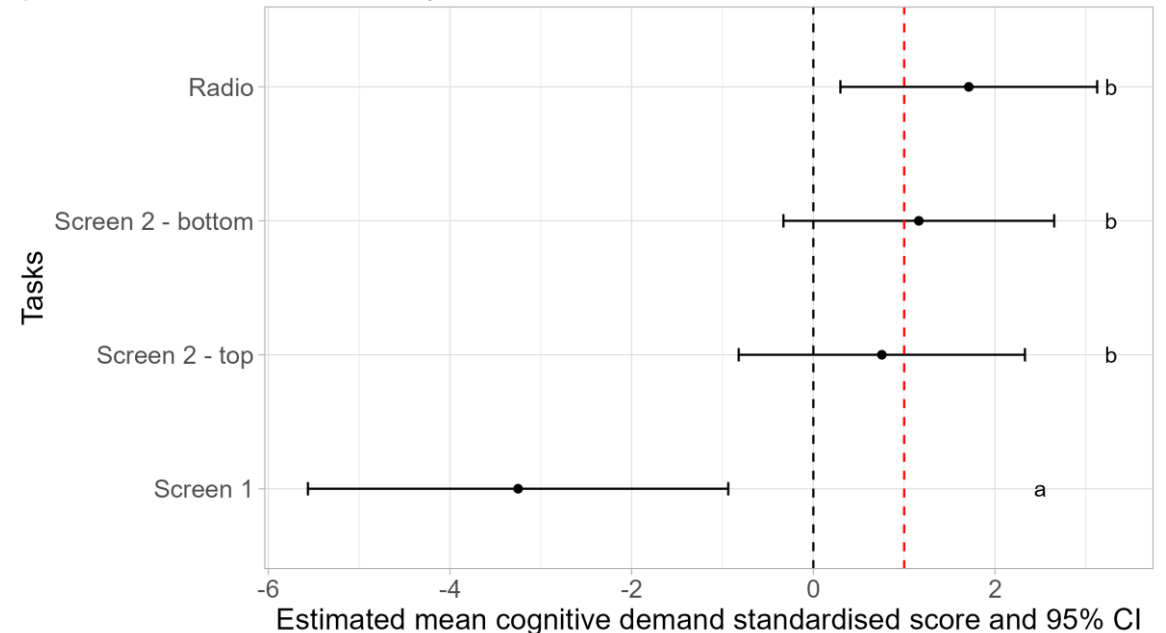… but partly under the levels for high demands

RESULTS (2/2)

Visual demand
(n = 17; Task type : $F_{(3, 218.25)} = 8.36$, $p < 0.001$)

Cognitive demand
(n = 12; Task type : $F_{(3, 306.26)} = 6.77$, $p < 0.001$)

Visual & cognitive demands higher for any interactions with the 2nd screen of the application

… and around or above the levels for high demands

CONCLUSION

Opportunity for road operators to alert road users using a application for real-time traffic information feedback without causing distraction:

- Possible from the 1st screen
- Would be an issue from the 2nd screen

Recommendations:

- Using 1st screen for urgent events and 2nd screen without driving
- Training road operators to improve application knowledge;
- Changing the interface:
  - Items' presentation on the 2nd screen (grid -> list presentation; Kujala and Saariluoma, 2011),
  - font size,
  - contrast

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Thanks for your attention

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Attentional demands of using an application for real-time traffic information feedback in road operators' vehicles

REFERENCES

Alliance of Automobile Manufacturers, & Driver Focus-Telematics Working Group. (2006). *Statement of principles, criteria and verification procedures on driver interactions with advanced in- vehicle information and communication systems including.* https://autoalliance.org/wp-content/uploads/2018/08/Alliance-DF-T-Guidelines-Inc-2006-Updates.pdf

Campbell, J. L., Carney, C., & Kantowitz, B. H. (1998). *Human factors design guidelines for Advanced Traveler Information Systems (ATIS) and Commercial Vehicle Operations (CVO)* (FHWA-RD-98-057). Battelle Human Factors Transportation Center. https://www.fhwa.dot.gov/publications/research/safety/98057/toc.cfm

Campbell, J. L., Lichty, M. G., Brown, J. L., Richard, C. M., Graving, J. S., Graham, J., O'Laughlin, M., Torbic, D., & Harwood, D. W. (2012). *Human Factors Guidelines for Road Systems : Second Edition* (NCHRP Report 600). Transportation Research Board. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_600Second.pdf

Chahir, M., Bordel, S., & Somat, A. (2019). Étude d'impact organisationnel chez les gestionnaires routiers—Rapport final de l'action de recherche—Accompagnement des évolutions organisationnelles et humaines introduites par la conception et le déploiement d'une innovation technologique (C-ITS) par l'analyse du système humain-technologie-organisation (Livrable du projet SCOOP 2.3.5.3; p. 94).

Kujala, T., & Saariluoma, P. (2011). Effects of menu structure and touch screen scrolling style on the variability of glance durations during in-vehicle visual search tasks. *Ergonomics*, *54*(8), 716-732. https://doi.org/10.1080/00140139.2011.592601

Reimer, B., Mehler, B., Dobres, J., & Coughlin, J. F. (2013). The effects of a production level « voice-command » interface on driver behavior : Reported workload, physiology, visual attention, and driving performance (MIT AgeLabTechnical Report No 2013-17A). Massachusetts Institute of Technology.

Strayer, D. L., Cooper, J. M., Goethe, R. M., McCarty, M. M., Getty, D. J., & Biondi, F. (2019). Assessing the visual and cognitive demands of in-vehicle information systems. Cognitive Research: Principles and Implications, 4(1), 18. https://doi.org/10/gf7kgd