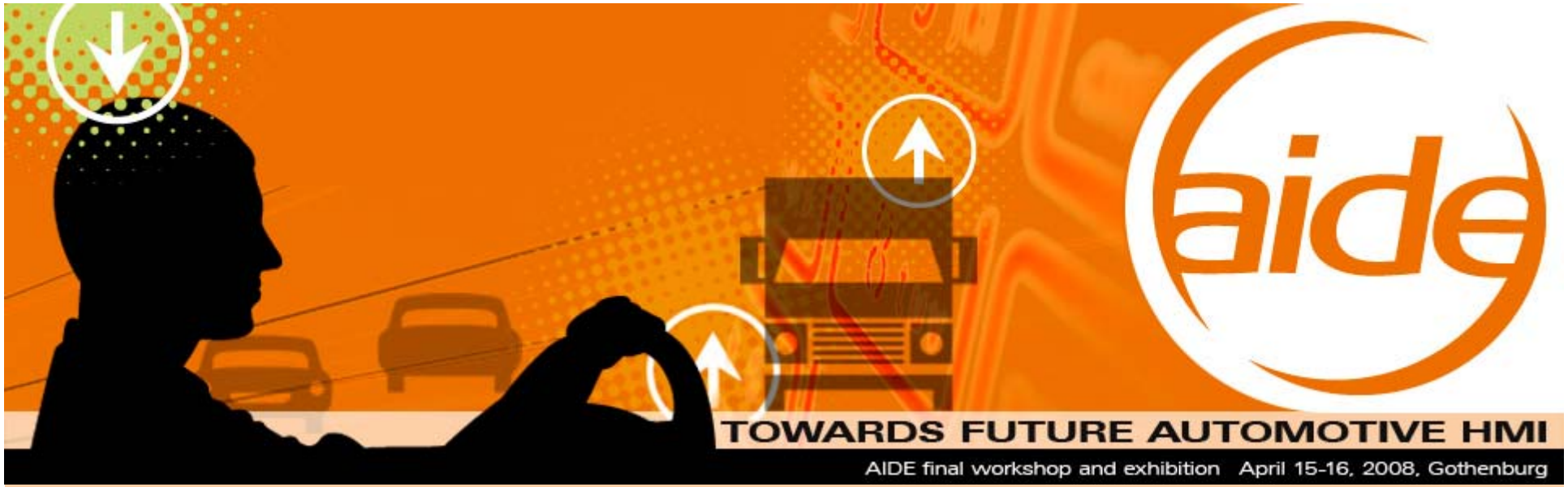


Results on the development of workload and distraction metrics and tools (WP2.2)

Emma Johansson (VTEC)

Partners

- Partners in WP2.2:

  BASt, BMW, CRF, Daimler,
  INRETS, KITE, PSA, REGIENOV,
  TNO, VTEC,VTI,
  UNIVLEEDS, USTUTT

Goal

- Develop a set of specific workload and distraction measurements (off-line) methods and tools for evaluation purposes feasible to use in an industrial setting and to be incorporated into the general AIDE methodology
- Further develop workload and distraction methods and tools based on findings in e.g. HASTE, ROADSENSE, ADAM, CAMP

Areas of work

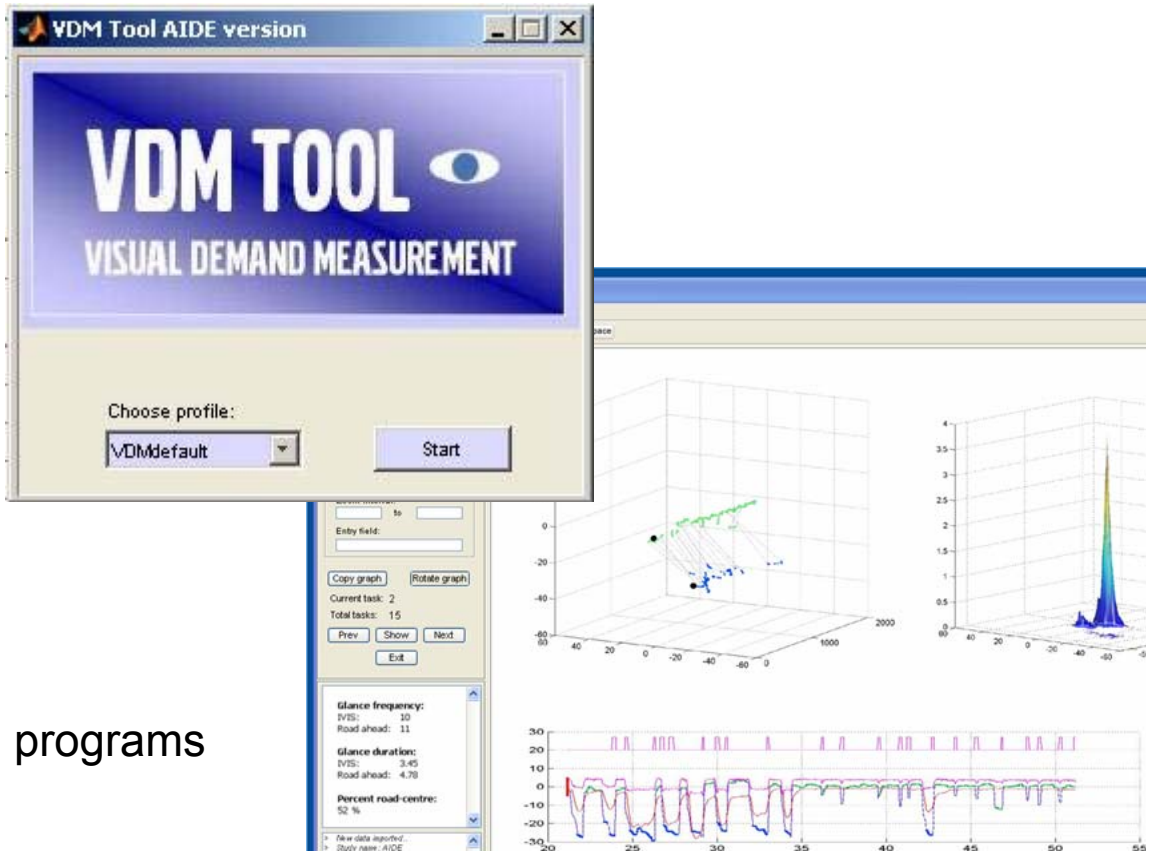
- Eye movement related metrics and tools:
  - Visual Demand Measurement (VDM) tool development
  - Enhanced Occlusion technique
- Secondary task methodology:
  - Comparison of different detection tasks with visual, audio and tactile stimuli
- Driving performance metrics and methods
  - Investigation of different driving performance metrics
  - Further exploring the Lane Change Test
- Subjective assessment methods

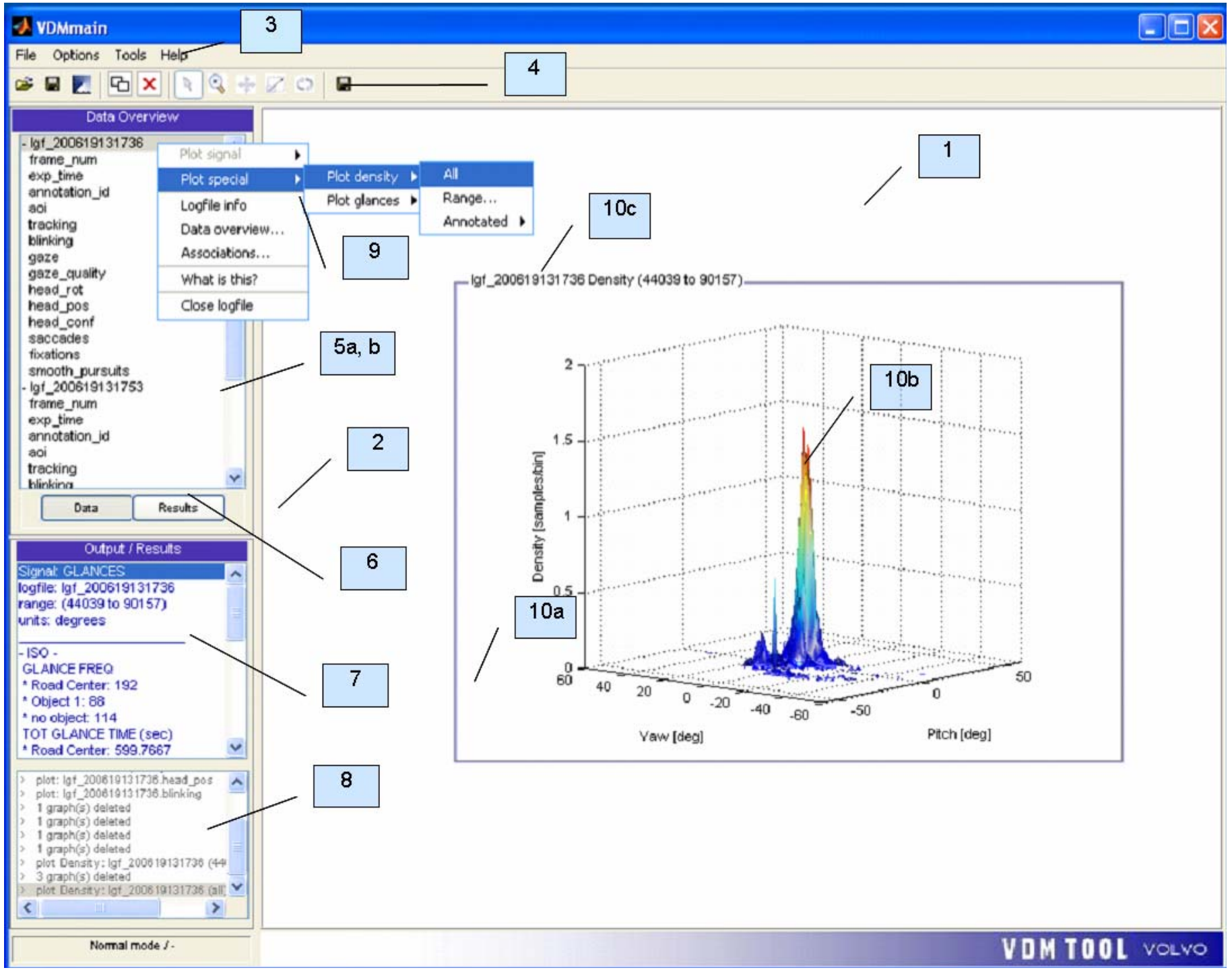
- Leading into: Empirical comparison of approaches

Visual Demand Measurement tool

- Goal: enhance the analysis process of eye movements!

- Make a tool which is:
  - fast,
  - inexpensive,
  - robust, and
  - easy-to-use…
- Data from a range of different sensors:
  - FaceLAB v 4,
  - SMI,
  - ETS
- Off-line analysis in VDM tool and further analysis in statistical programs

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Data Overview
- lgf_200619131736
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Data
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Logfile info
Data overview...
Associations...
What is this?
Close logfile
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Signal: GLANCES
logfile: lgf_200619131736
range: (44039 to 90157)
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GLANCE FREQ
* Road Center: 192
* Object 1: 88
* no object: 114
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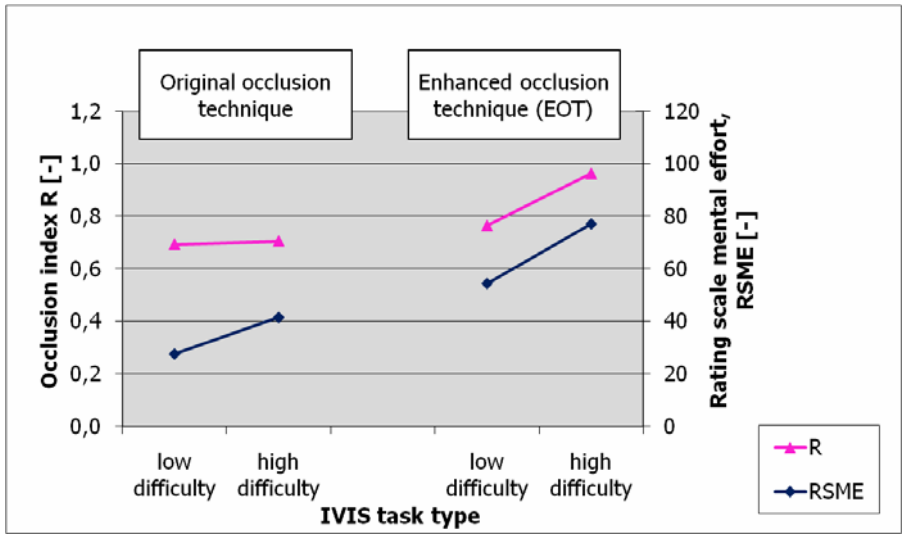
VDM TOOL VOLVO

Enhanced Occlusion Technique

- Issues with the traditional Occlusion Technique: poor representation of real-world conditions because of its lack of a cognitive loading task during the occlusion intervals
- In AIDE: trad. set up with occlusion goggles. Addition of a continuous cognitive and sensomotor task (tracking task) performed in parallel with the IVIS task



Signal Detection Task

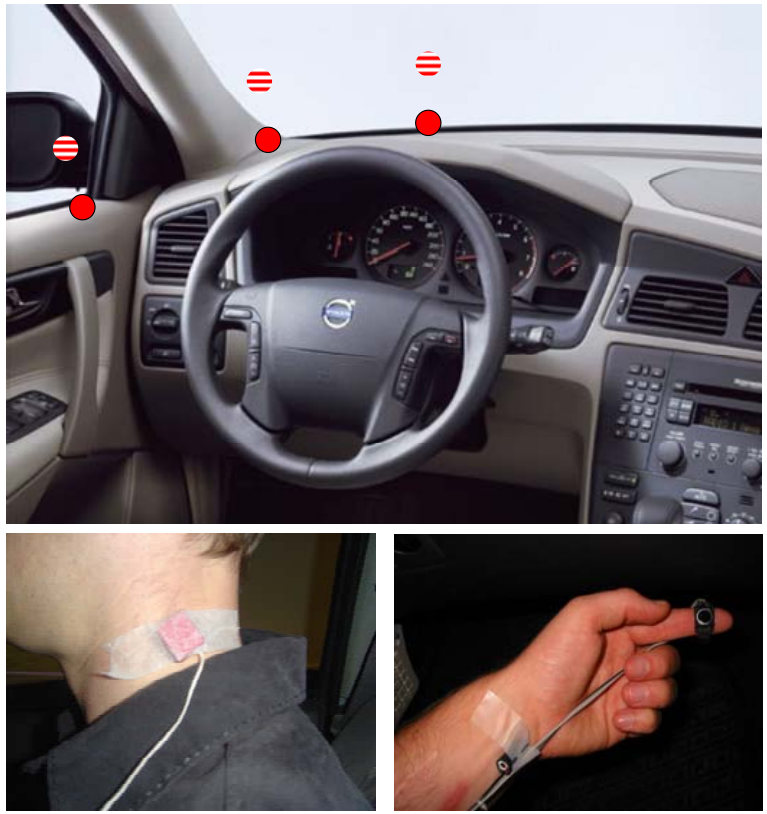
- Starting point:
  - the Peripheral Detection Task method (e.g. Martens & Van Winsum, 1999)
  - visual stimuli in the peripheral view (e.g. by reflecting Light Emitting Diodes)

- In AIDE two main research questions:
  - is sensitivity to demand depending on *stimuli eccentricity* and
  - is sensitivity to demand depending on *stimuli modality*?

- Reason for testing alternative detection tasks:
  - assumption that workload leads to general interference rather than visual tunneling (e.g. Recarte and Nunes, 2003) and
  - that sensitivity to demand therefore does not depend on eccentricity or modality

Signal Detection Task

- Alternatives compared:
- Visual stimuli:
  - 3 different positions of the visual stimulus:
    - *Centered*,
    - *Left*,
    - *Far left* in drivers field of view
- Tactile stimuli:
  - *Neck*, *Wrist* and *Seat*
- Audio stimuli: audio beeps



Signal Detection Task

- Results – examples:

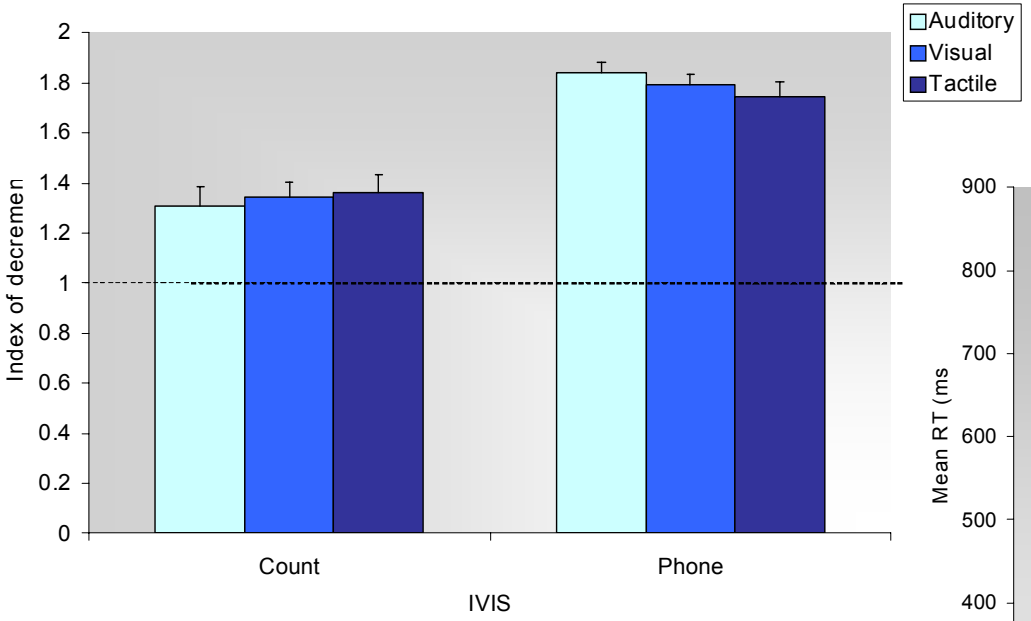


Figure 1 – The effect of each IVIS on index of decrement in the DT

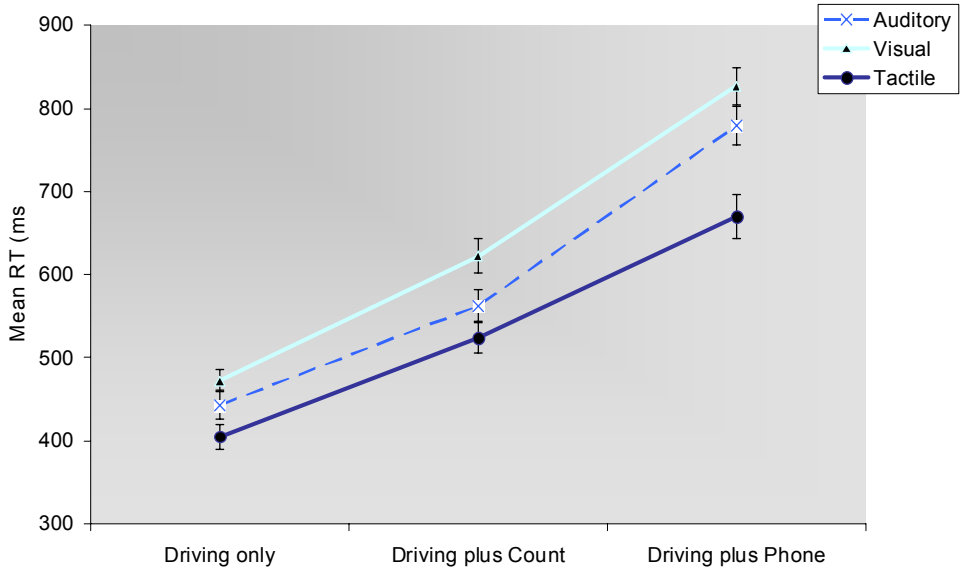
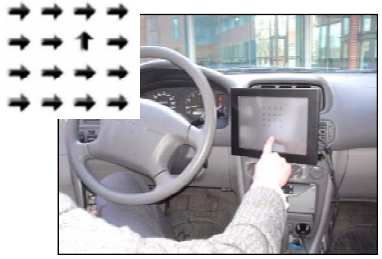


Figure 2 – Reaction time to each DT

Driving performance metrics

- General objectives:
  - Provide detailed operational definitions of common driving performance metrics
  - Further development of some key metrics, in particular standard deviation of lane position (SDLP) and steering wheel reversal rate (SRR)
- Re-used data collected in the HASTE EU project during 2003-2004



Visual: Arrows task

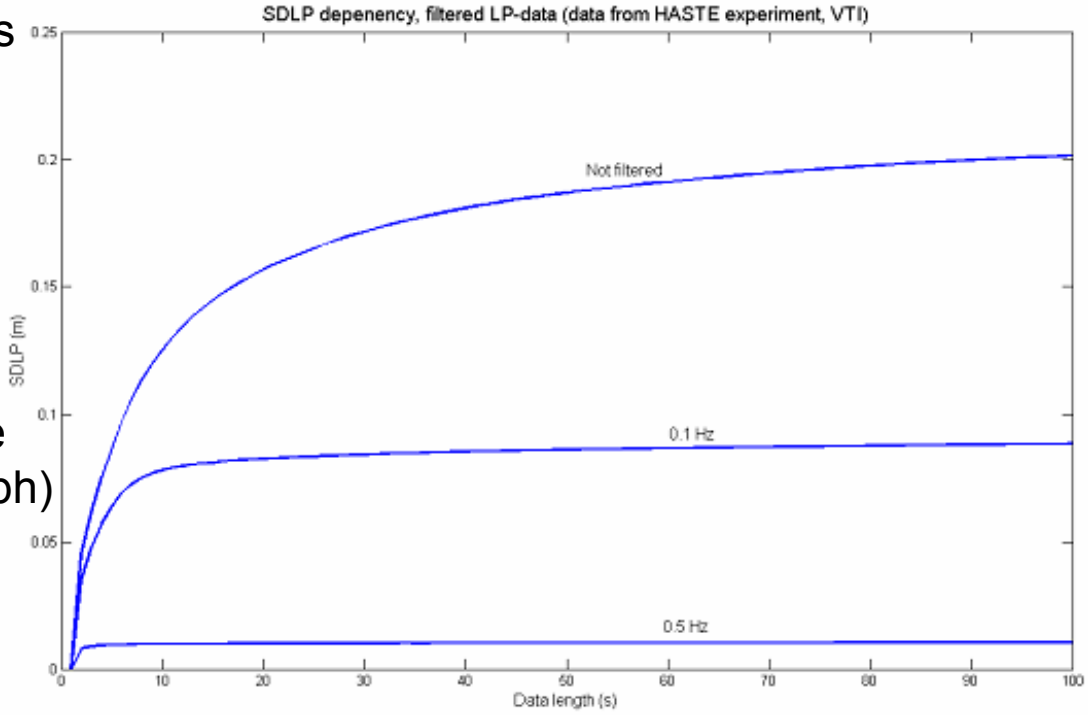
Auditory Continuous Memory Task (aCMT)

Auditory/cognitive: aCMT

3 difficulty levels each

Driving performance metrics

- *Modified* Standard Deviation of Lane Position (mSDLP)
  - Key problem: SDLP depends to a large extent on data duration (figure below, top graph)
  - Proposed solution: High-pass filtering at 0.1 Hz largely removes the duration dependency for tasks longer than 10 seconds (mid graph)
  - Too much filtering also takes away the relevant variance (e.g. the treatment effect one wants to assess, bottom graph)
  - Data lengths of at least 10 seconds are comparable
  - Increase – visual distraction
  - Decrease – cognitive load

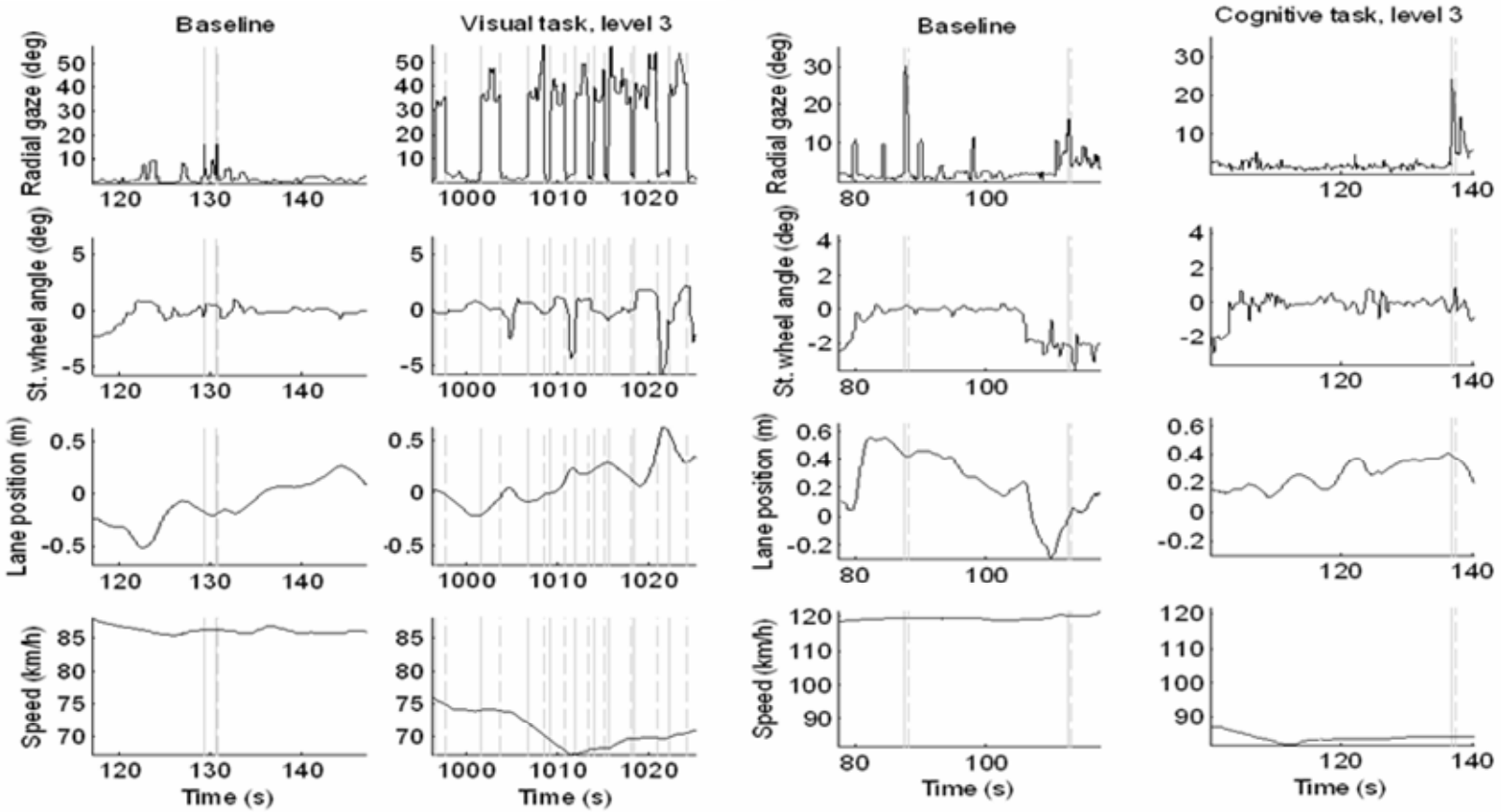


Driving performance metrics

- Steering wheel reversal rate (SRR)
  - Re-analysis of existing data from 'HASTE'
    - Simulator and Field data
    - Two secondary tasks (surrogate (S)- IVIS): Visual (arrows task) and Auditory/cognitive: Auditory Continuous Memory Task
    - Comparison of effect sizes

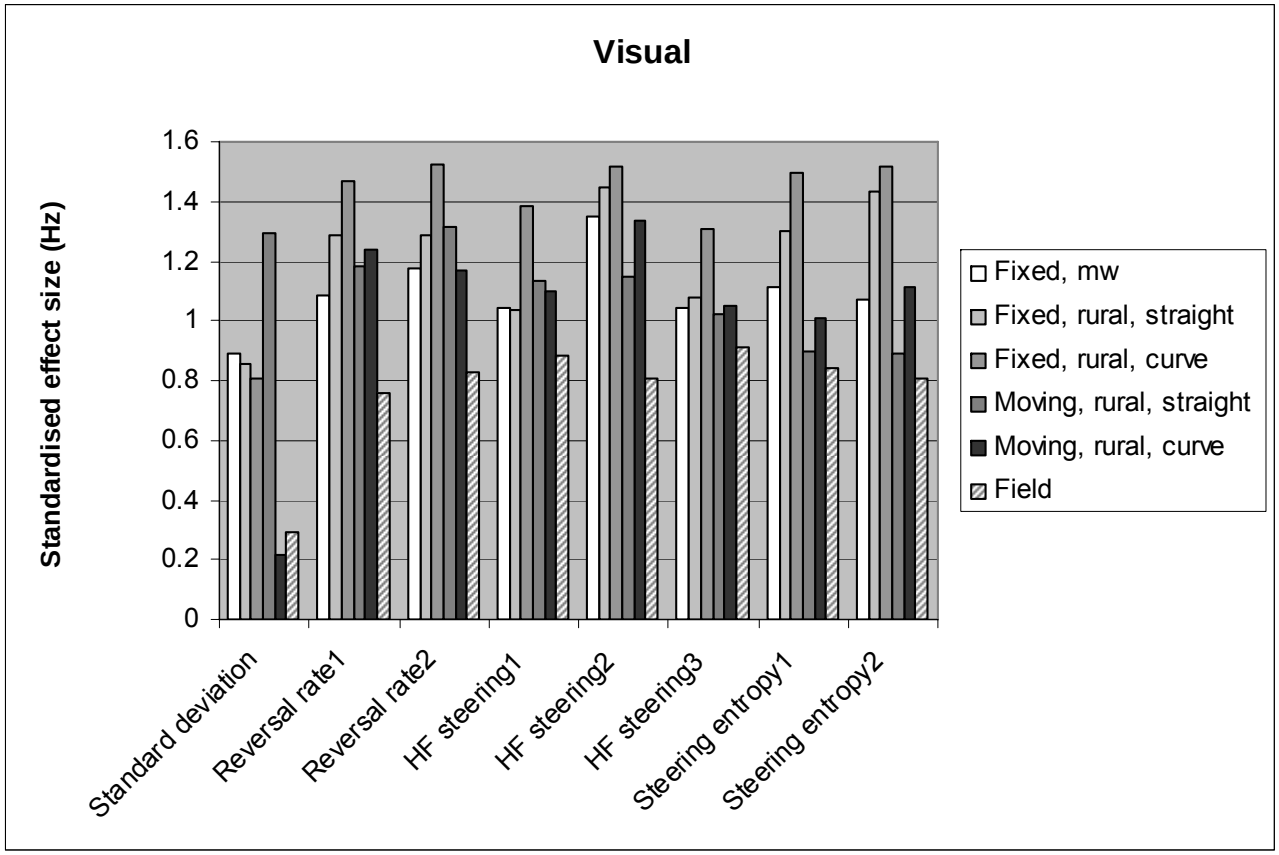
Driving performance metrics

- Steering Wheel metrics - Qualitative analysis – time series with synchronised data



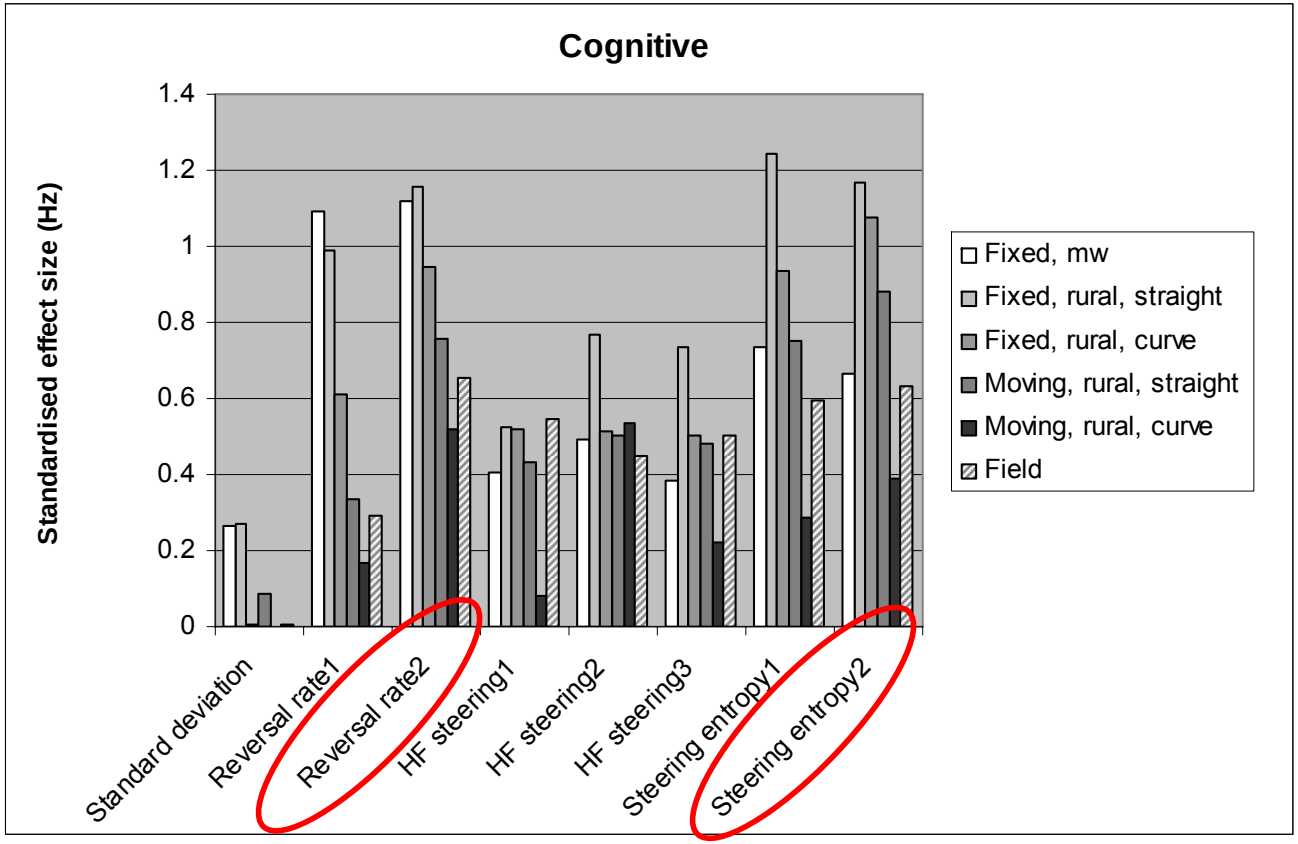
Driving performance metrics

- Steering Wheel metrics - Sensitivity analysis, visual task (effect sizes)



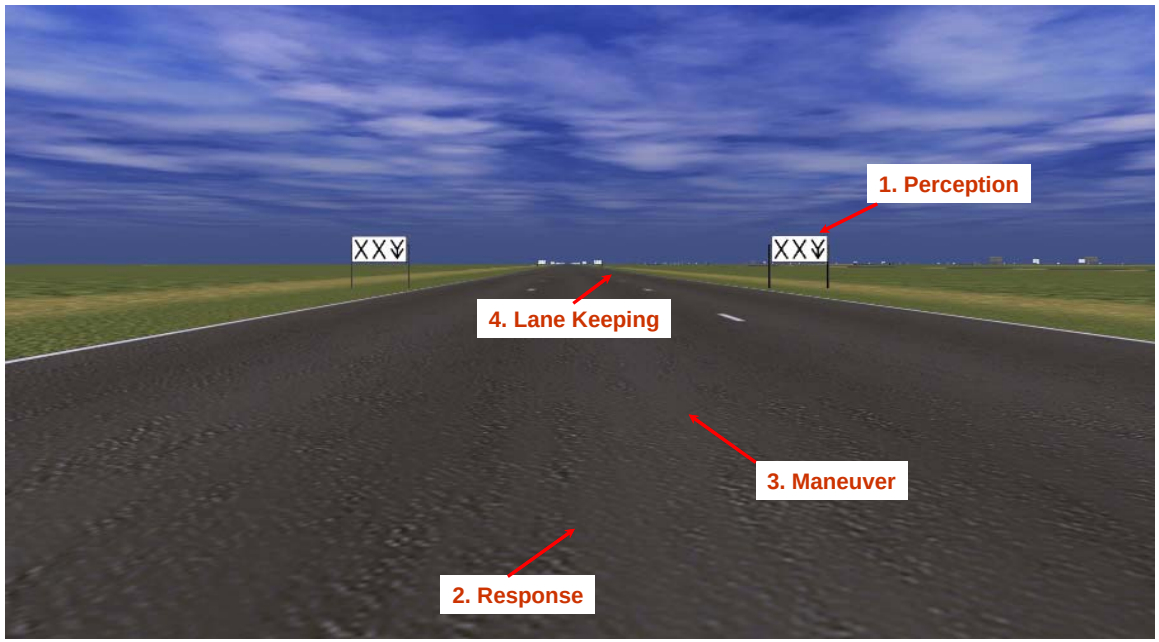
Driving performance metrics

- Steering Wheel metrics - Sensitivity analysis, cognitive task (effect sizes)



Lane Change Test

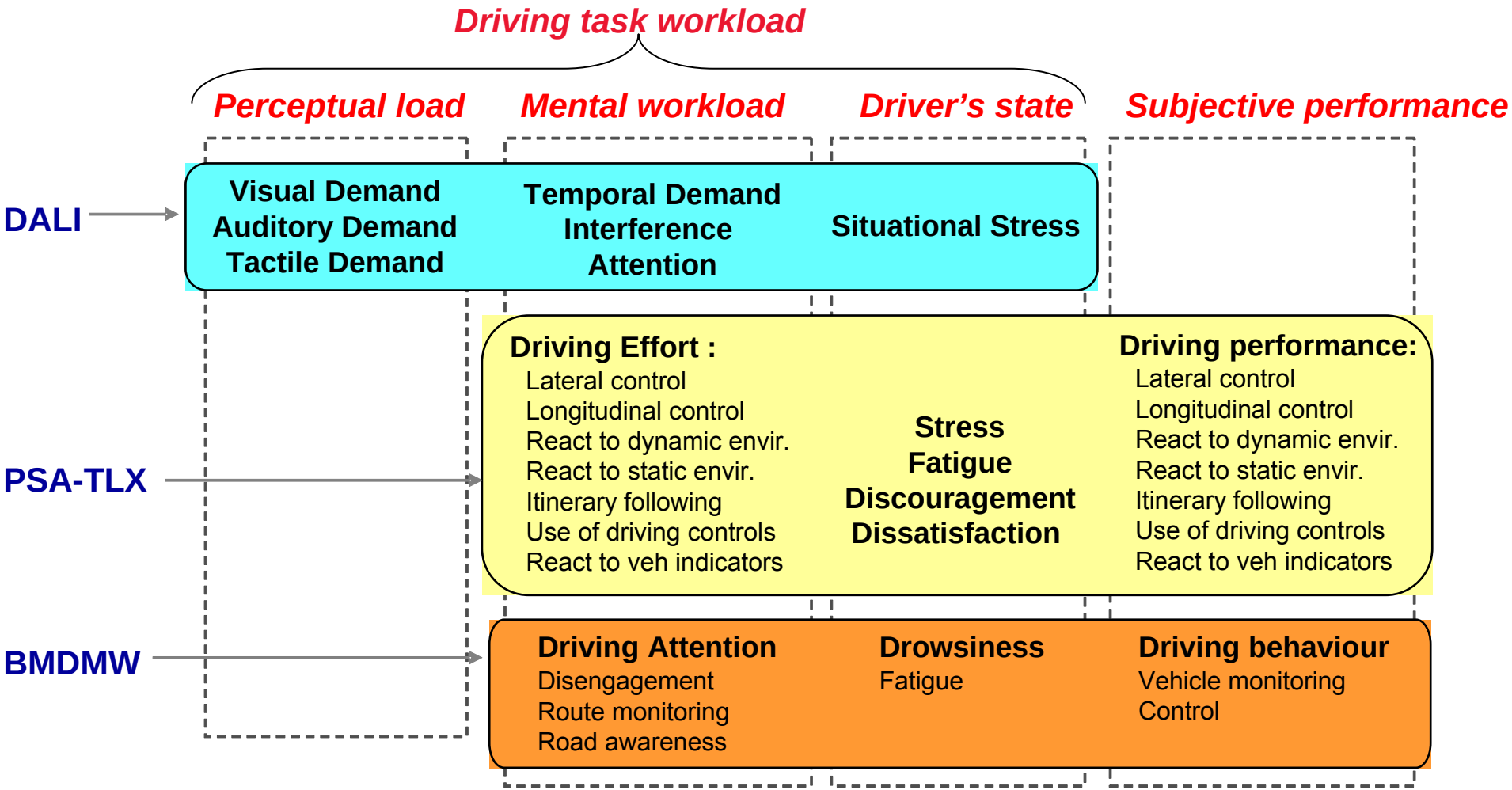
- LCT: low-cost driving simulation to estimate driver distraction caused by in-vehicle devices. The driver has to change the lane according to the signs along the simulated roadway (see below).
- Examples of research questions in AIDE: How does the LCT work with different *IVIS Task modalities, Adaptive systems* and in *Different environments*



Lane Change Test

- Example of results:
  - Different modalities – hypotheses tested:
    - Visual tasks affect both the path control during the lane change and responses to lane change signs
    - Purely cognitive tasks affect responses to the lane change signs, but has no degrading effect on path control
  - Conclusions
    - Visual tasks mainly affected path control (SDLP) but (contrary to the hypothesis) no significant effect on responses to signs (PCL)
    - Cognitive task (hard version) did not affect path control (SDLP) at all, but strongly affected responses to signs (PCL) (cf. inattentional blindness)
    - The hypotheses were generally confirmed (except for the lacking effect of the visual tasks on responses to signs) → visual and cognitive tasks lead to different types of driver errors
    - Effects on path control and responses to signs can be assessed separately using the proposed performance metrics
    - These metrics (together with others, e.g. lane change initiation) could be used as complements to the MDEV metric to increase the diagnosticity of the LCT method

Subjective workload methods



Subjective workload methods

Constraint	Methods	Comments
Simulator	**DALI** **BMDMW**	PSA-TLX not designed for simulator
Road	**DALI** **BMDMW** **PSA-TLX**	Depends on evaluation objectives No use of both DALI and PSA-TLX (potential interference : factors, scoring, reference situation)
Practical time constraint	**DALI** **BMDMW**	DALI and BMDMW = quick administration and data analysis PSA-TLX requires time for the 1st administration and data analysis
HMI specification	**DALI**	DALI evaluates perceptual load variation between two solutions
Disruption induced by system use	**PSA-TLX** **DALI** **BMDMW**	PSA-TLX measures driving disruption (effort and performance) DALI estimates interference and effort of attention BMDMW emphasizes driving behaviour
Safety impact	**PSA-TLX** **BMDMW**	PSA-TLX proposes decision criteria (Effort and Performance) BMDMW reveals risky driving behaviour