DRT sensitivity to driving demand and task difficulty

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Introduction

• DRT = Detection-Response Task
• Currently discussed in ISO TC22SC13WG8
  – Developing tests inexpensive, quick to complete, easy to administer and capable of measuring aspects of drivers’ distraction
• DRT to measure effects of cognitive load of a secondary task on driver’s attention
  – Response to frequent stimuli (each 3 to 5 sec)
  – Performance: RT & hit rates
• Objectives
  – DRT sensitivity to driving task demand?
  – DRT sensitivity to secondary task level of difficulty?
Driving simulator
Method

- 16 participants 25-45 years old (8 males & 8 females)
- Conditions per participant
  - 4 DRT conditions: without any DRT, Head-mounted, Remote (center), Tactile
    Order counter-balanced across subjects
  - 2 driving scenarios
    - Low driving demand: Highway
    - High driving demand: Curvy road
  - 5 tasks: Ba, N0, N1, S0, S1
    Order of tasks counter-balanced across subjects and DRT
- Task duration: 60 seconds each
- RT cut-off for DRT: [100 ms-2000ms]
3 DRT versions

- **Head-mounted**
- **Remote**
- **Tactile**
2 Driving scenarios: Highway

- Driving on a 2X2 lanes, speed limited to 130km/h
- Continuous drive for each DRT condition (Without DRT, HDRT, TDRT, RDT)
- 4 distractive tasks + 3 baselines (60s each)
- Order of tasks counter-balanced across subjects and DRT conditions
- At least 30s of driving between each task
2 Driving scenarios: Curvy road

- Baselines and dual tasks in the series of curves
- Continuous drive for each DRT condition
- Same secondary tasks
- Order of tasks counter-balanced across subjects and DRT conditions
- At least 30s between each series
4 Distractive tasks

SuRT easy and hard

N-back easy and hard

- N0: Repeat the last number
- N1: Repeat the number heard before the last
Results: DRT Response Times

Global effects
(repeated measures Anova)

- Significant effect of **driving task demand** \((p=0.001)\)
- Significant effect of **DRT version** \((p<0.001)\)
  \[
  RT_{\text{Tactile}} < RT_{\text{Remote}} \quad \text{and} \quad RT_{\text{Tactile}} < RT_{\text{Head}} \quad (p<0.05)
  \]
  no significant difference between \(RT_{\text{Head}}\) & \(RT_{\text{Remote}}\)
Results: DRT Response Times

Global effects
(repeated measures Anova)

- Significant effect of tasks \( (p<0.001) \)
- Significant differences between all tasks except SuRT_{easy} & SuRT_{hard}
  \[ RT_{BA} < RT_{N0} < RT_{N1} < RT_{SuRT} \; (p<0.05) \]
Results: Miss rate

Global effects
(Friedman and Wilcoxon tests)

• Significant effect of **driving task demand** (*p*<0.001)
• Significant effect of **DRT version** (*p*<0.001)
  TDRT different from HDRT & RDRT (*p*>0.05),
• Significant effect of **Tasks** (*p*<0.05): B < N0 < N1 < S0 < S1
Results: SURT Performance

RT per SuRT screen
(repeated measures Anova)

- Significant effect of driving demand ($p=0.001$)
- Significant effect of DRT version ($p=0.041$)
- Significant effect of task difficulty ($p<0.001$)
- Significant interaction of driving demand and task difficulty ($p=0.001$)
Results: Subjective evaluation

Subjective evaluation of difficulty to execute task(s) simultaneously

- Significant effect of driving demand (p<0.002)
- Significant effect of DRT version (p<0.038)
  - Baseline without DRT different from all conditions (p>0.05),
  - No significant difference between DRT versions
- Significant effect of tasks (p<0.001): B < N0 < N1 < S0 < S1
Conclusions

• **DRT sensitive to the driving demand**
  – Confirmed by drivers’ subjective evaluation
  – In line with other studies

• **DRT sensitive to task difficulty**
  – $BA < N0 < N1 < S0 \& S1$

• **DRT sensitivity to visual-manual tasks?**
  – $SuRT = \text{driver paced task, possibility to neglect its execution and preserve DRT performance}$
    ⇒ participants more willing to execute $SuRT$ easy than $SuRT$ hard
    (DRT performances more affected in $SuRT$ easy)
    ⇒ Necessity to address how drivers prioritize attention toward the tasks, especially in triple task condition
  - BUT also possible **ceiling effect** of DRT sensitivity to discriminate between tasks of too difficult levels
    ⇒ Triple task condition
    ⇒ Perceived difficulty increases between $SuRT$ easy and hard (extremely difficult) => reach limits of resources?
Thank you!

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