

# How do you assess the distraction of in-vehicle information systems?

## A comparison of occlusion, lane change task and medium-fidelity driving simulator methods

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# Background

- Distraction concerns for In-Vehicle Information Systems (IVIS)
  - ◆ Particularly visual
- A range of Human Factors methods are available to designers to aid in the assessment of IVIS user-interfaces
- Formative methods are considered to be especially important, as part of a user-centred design process
- Criteria for a 'good' method (and measures):
  - ◆ Validity.....
  - ◆ Reliability
  - ◆ Sensitivity
  - ◆ Usability
  - ◆ Economy
  - ◆ Etc...



# Aim of Research

- Focus on *criterion validity* of measures employed in IVIS evaluation
  - ◆ “the effectiveness [of a method] in predicting criterion, or indicators of a construct” (Walker, 2010)
- Research question: What is the criterion validity of two commonly employed IVIS evaluation methods intended for use in formative design?
  - ◆ Occlusion (TSOT)
  - ◆ Lane Change task (Mdev)
- Comparisons made with a higher fidelity human factors method
  - ◆ Medium-fidelity driving simulator

# Method – Occlusion protocol (ISO, 2007)

- At least 10 participants (2>50 years old; all licensed drivers)
- ‘Secondary’ Tasks conducted:
  - ◆ under conditions of occlusion
  - ◆ with full vision (unoccluded)
- For occlusion, cycle of 1.5 secs vision; 1.5 secs occlusion
- 5 variants for each task; training required for each task to ensure skilled performance



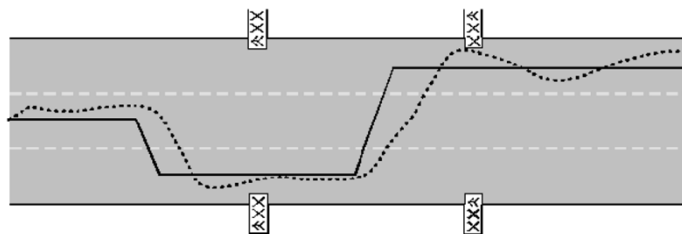
Key measure: Total Shutter Open Time (TSOT)

The sum of visual intervals under occlusion conditions

JAMA recommend <7.5secs; AAM recommend <15 secs; NHTSA recommend <12 secs

# Method – Lane Change Task (ISO, 2010)

- At least 16 participants
- Primary tasks:
  - ◆ Keep fixed speed (60km/h)
  - ◆ Change lanes when requested
- Secondary tasks:
  - ◆ Each task conducted continuously over 3 minute period



Key measure: Mdev

- A measure of lateral control obtained by comparing the actual driving trajectory of the participant to a reference trajectory



# Method – Medium-Fidelity Driving Simulator

- Commonly employed as a surrogate for real driving
- Key measures:
  - ◆ Secondary task time (STT)
  - ◆ Total glance time (TGT)
  - ◆ Mean glance duration to devices (MGD)
  - ◆ Number of off-road glances greater than two seconds ( $G > 2\text{secs}$ )
  - ◆ The standard deviation of Headway to lead vehicle (SDHW)
  - ◆ The standard deviation of Lane Position (SDLP)
  - ◆ The number of times the participant exceeded the lane (LANEX)
- Range of scenarios often employed (rural, motorway, urban, etc.)
- Relative validity well established for simulators of this level of fidelity (e.g. Reed and Green, 1999; Jamson, 2001; Shechtman et al., 2009)



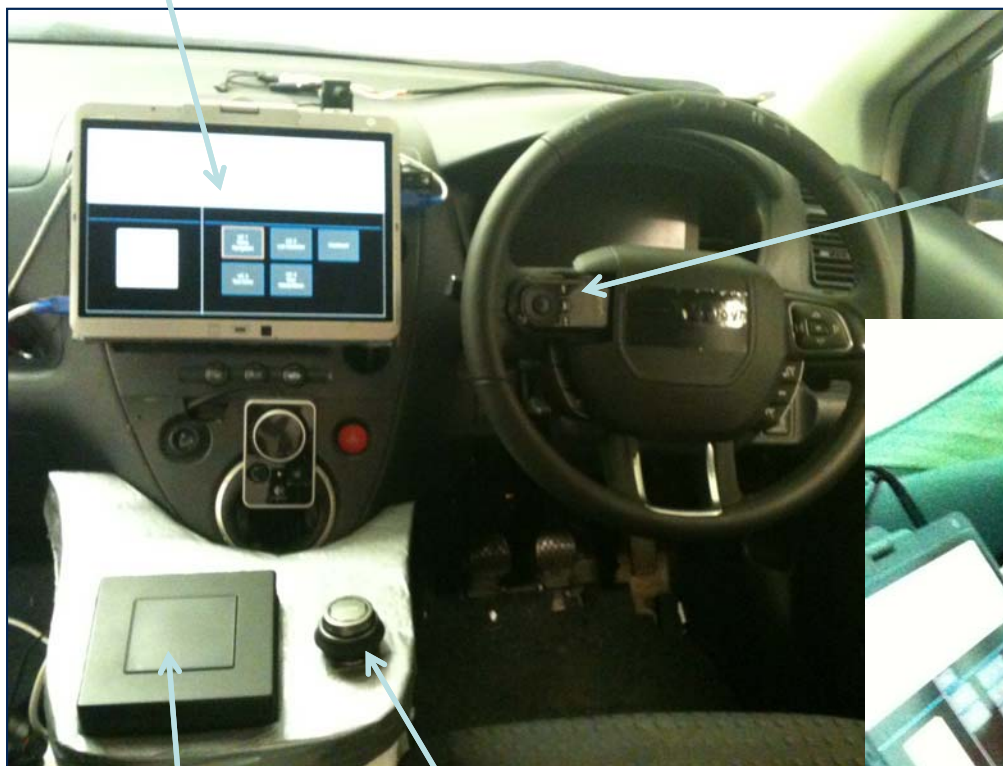
# Validity study details

- Participants
  - ◆ 14 experienced drivers (8 male; 6 female); mean age 29
- Tasks
  - ◆ Menu navigation task
  - ◆ List scroll task
  - ◆ Alphanumeric entry task
- Devices
  - ◆ Touchscreen
  - ◆ Touchpad
  - ◆ Rotary Controller
  - ◆ Steering Wheel controller
- Design
  - ◆ Within subjects



# Devices

Touchscreen (TS)



Steering Wheel Controller  
(SWC)

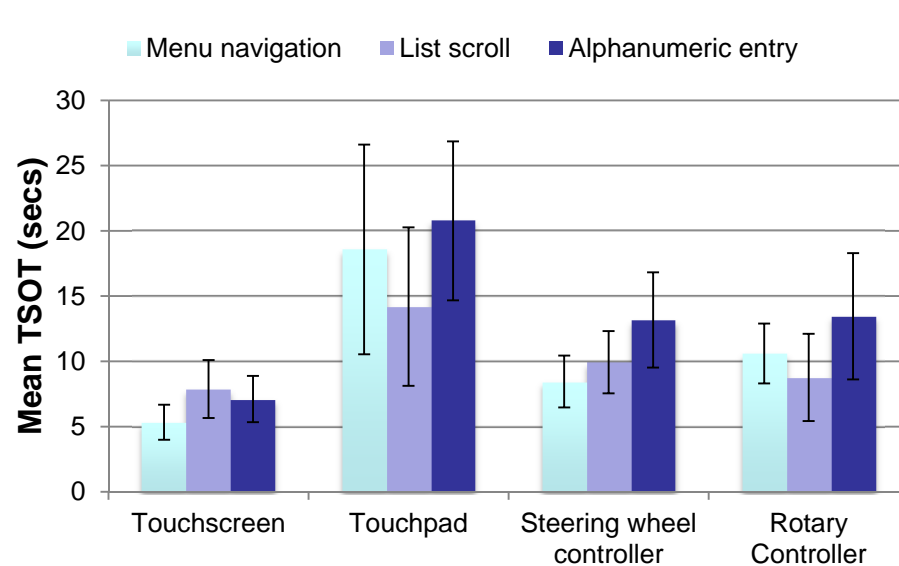


Touchpad  
(TP)

Rotary  
Controller (RC)

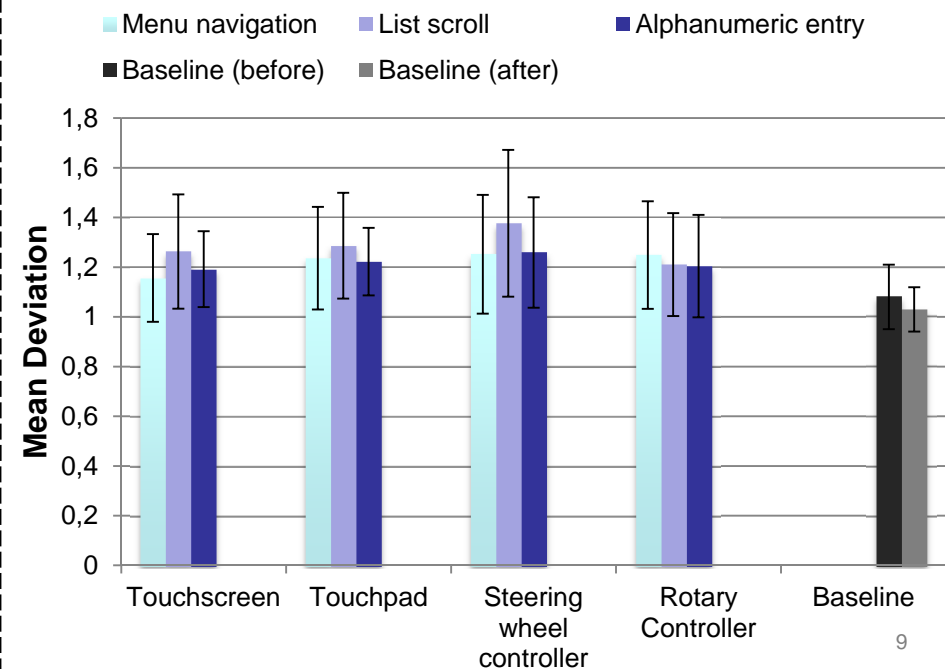


# Results – Means (TSOT, Mdev)

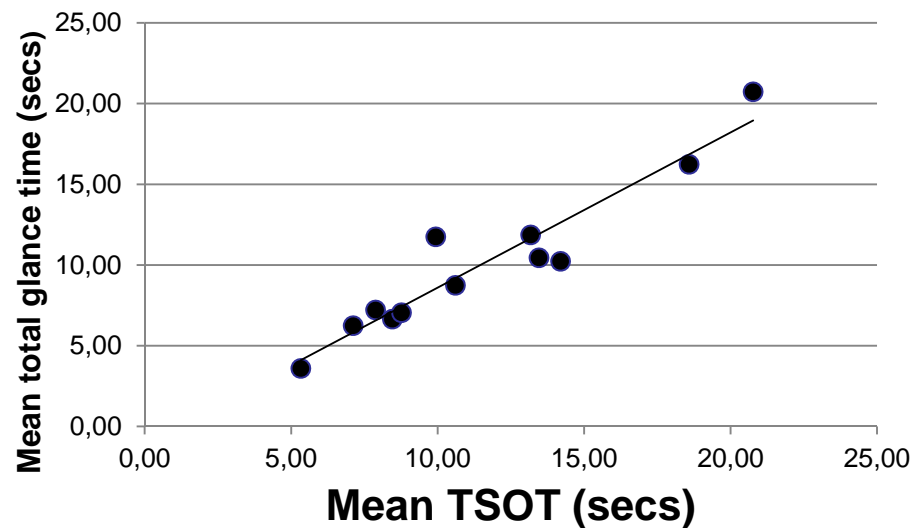


Occlusion

LCT

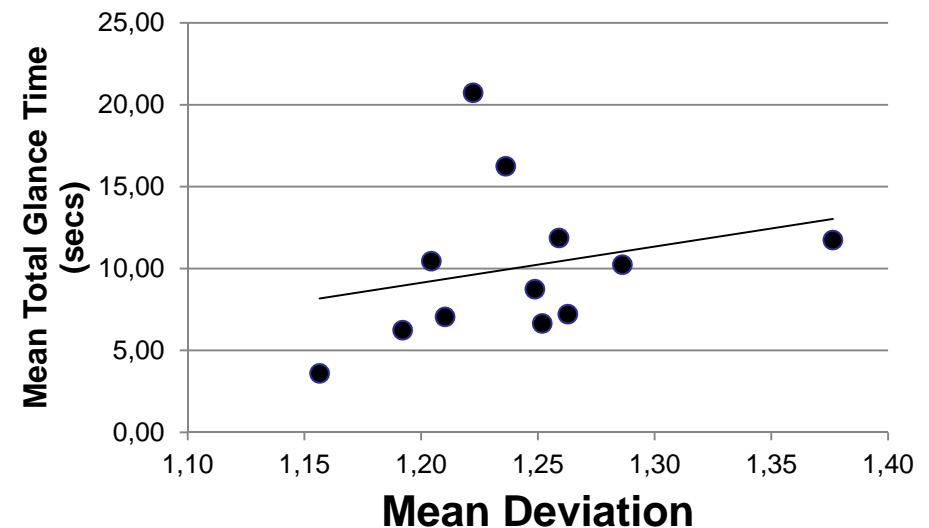


# Results – Total Glance Time



$R=0.95$

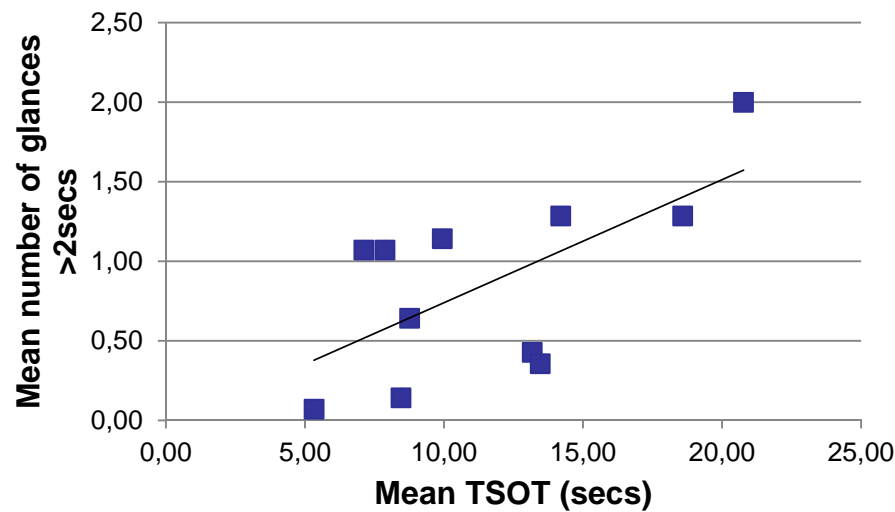
Occlusion



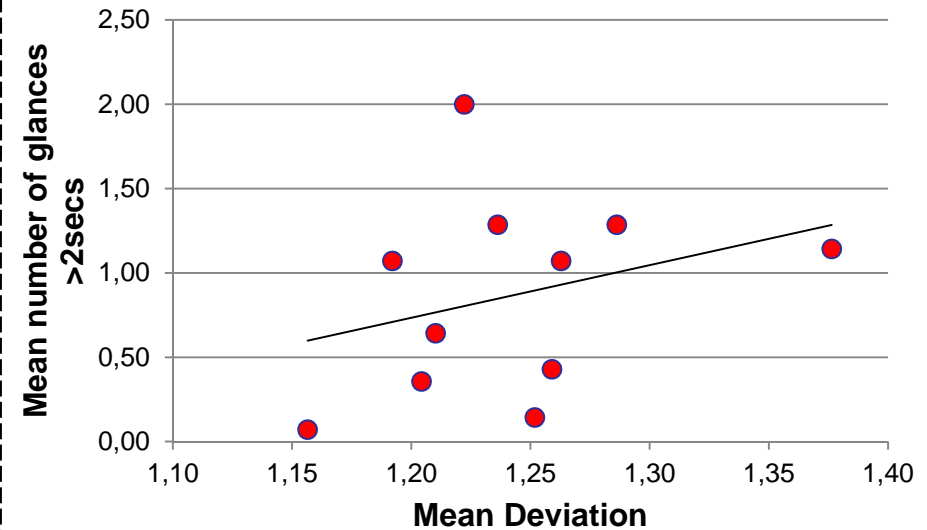
$R=0.26$

LCT

## Results – Glances > 2secs duration

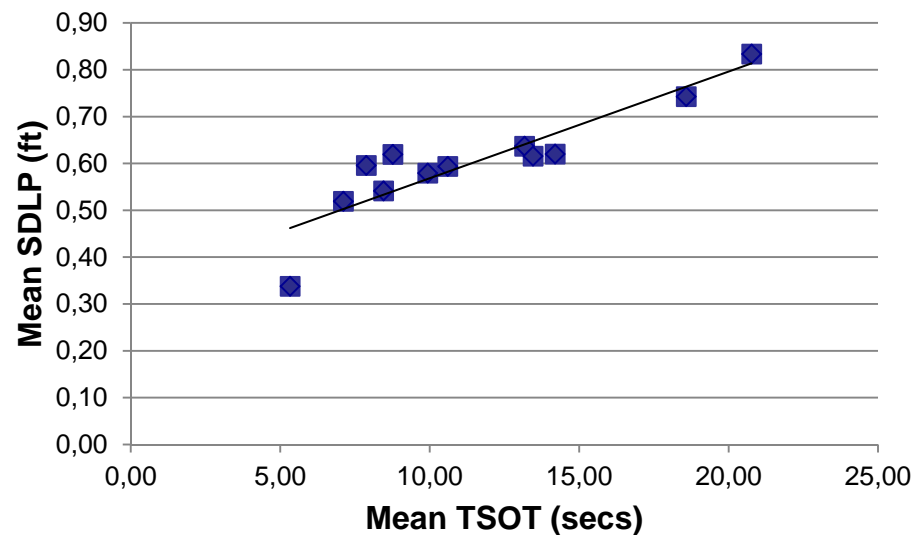


$R=0.62$

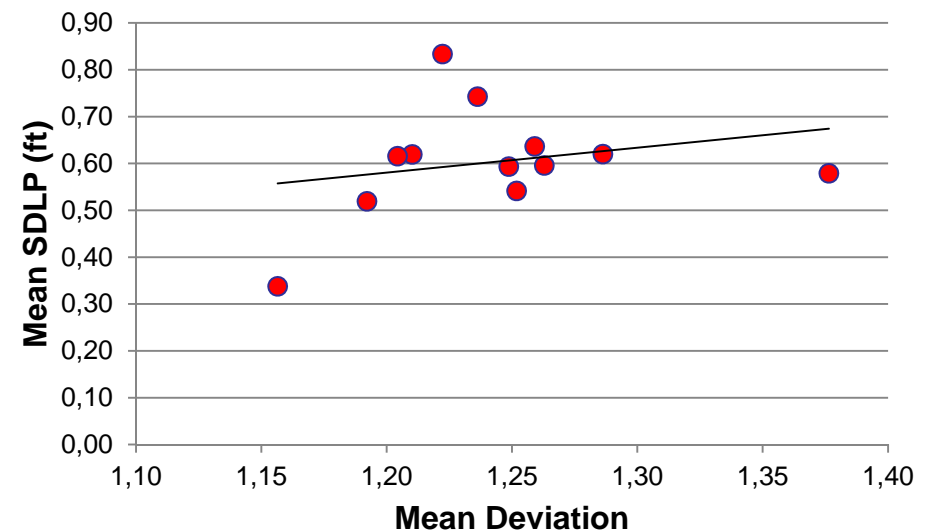


$R=0.26$

# Results – Standard deviation of lane position



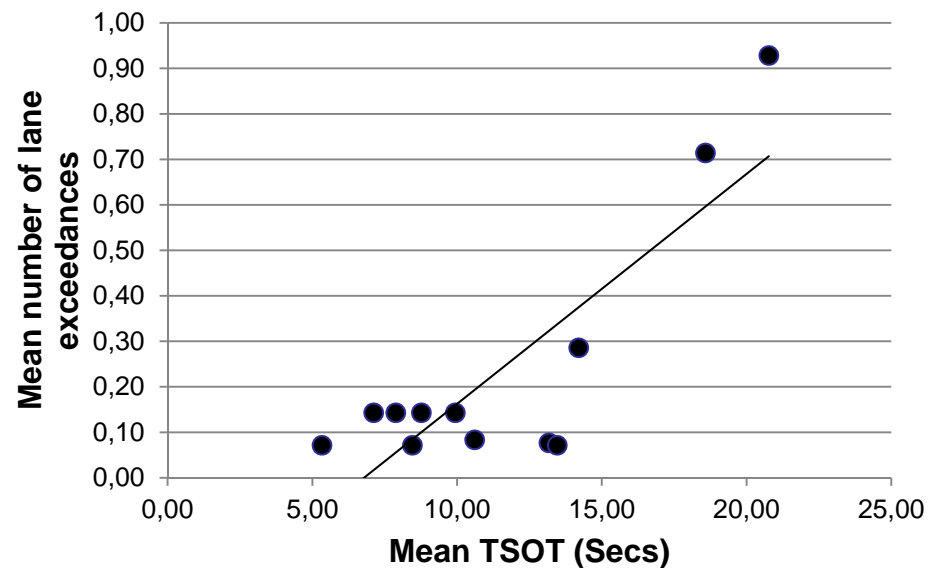
$R=0.89$



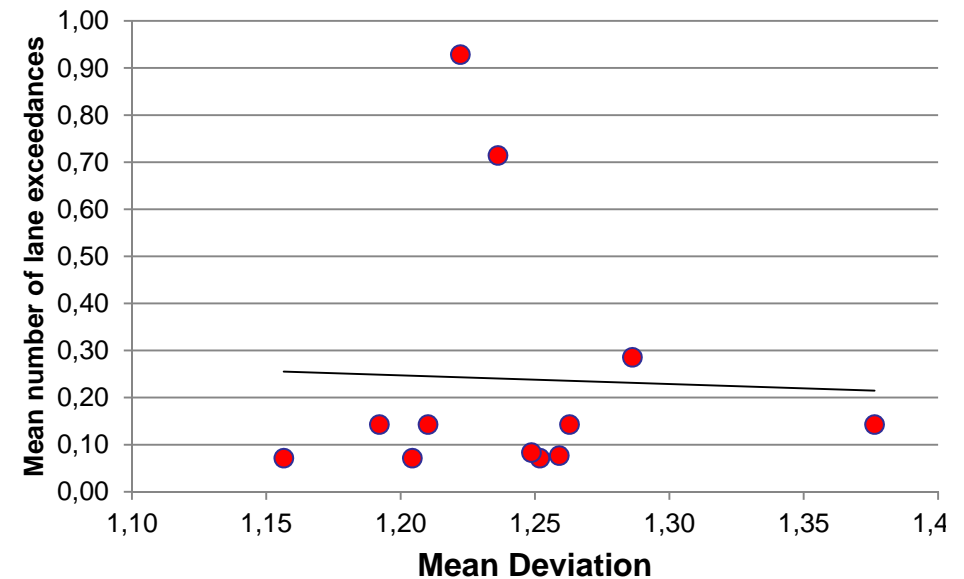
$R=0.23$



## Results – Number of lane exceedances



$R=0.84$



$R=-0.03$

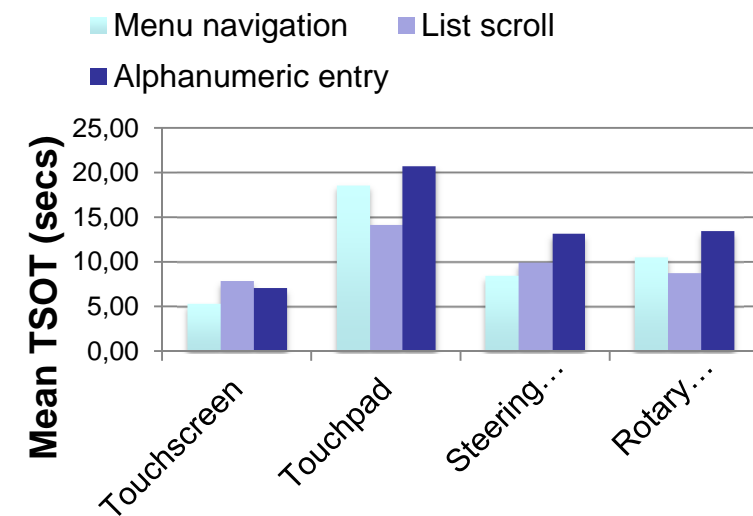
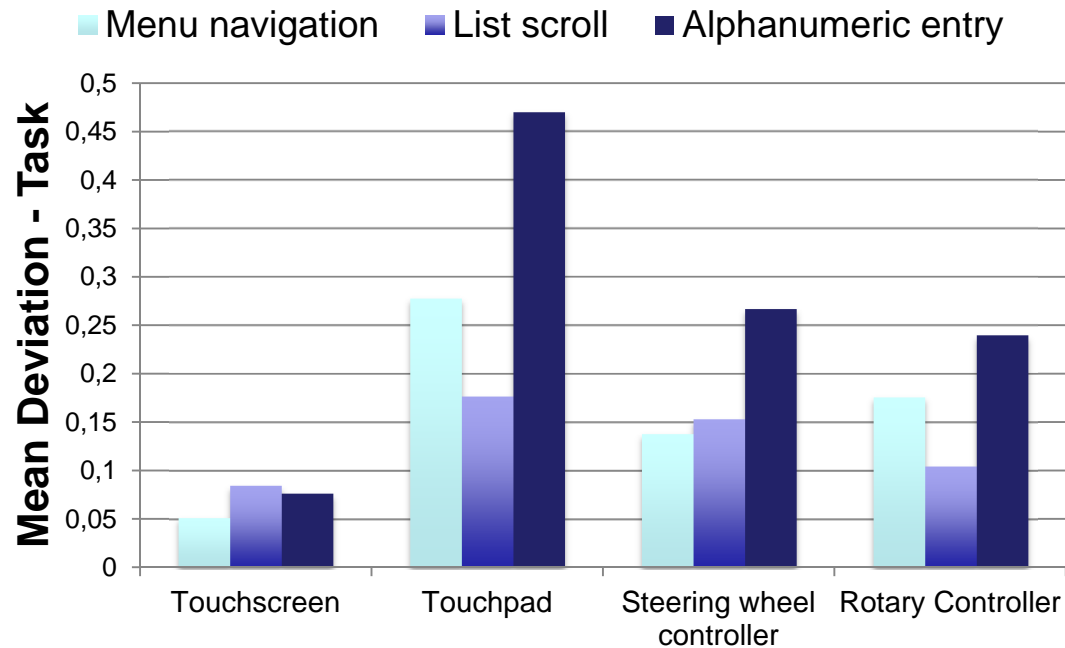
## Discussion (1) – Why does TSOT relate well to driver performance measures?

- TSOT has both a *time* component and an *intensity* component
- Exposure time to risk is critical for several driving performance measures
  - ◆ Secondary task time
  - ◆ Glance frequency
  - ◆ Total glance time
  - ◆ Number of lane exceedances
- Intensity (visual and/or cognitive) of interaction is critical for several driving performance measures:
  - ◆ Mean glance duration
  - ◆ Number of glances > 2secs
  - ◆ SD Lane position
  - ◆ SD Headway

## Discussion (2) – Why does Mdev relate poorly to driver performance measures?

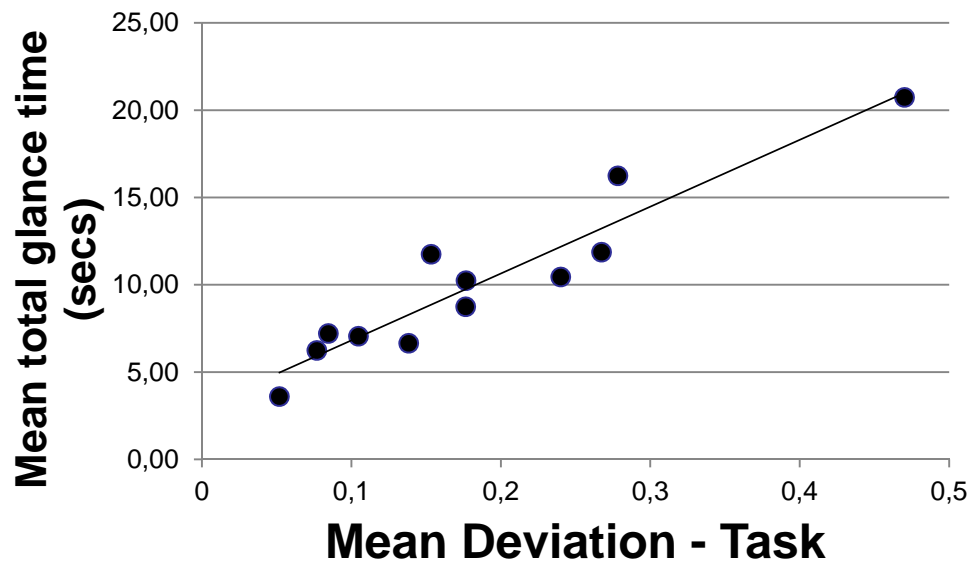
- LCT encourages individual differences in timesharing strategy:
  - ◆ Most apparent for the most difficult tasks
  - ◆ Deciding what is primary/secondary task
- No *time* component to the measure, purely an assessment of *intensity* of interaction
- So what happens if you do include a time component (as recommended by Harbluk, Mitroi and Burns, 2009)?.....
  - ◆  $Mdev_{Task} = Mdev / \text{number of tasks completed in 3 minute period}$

# Use of Mdev<sub>Task</sub>

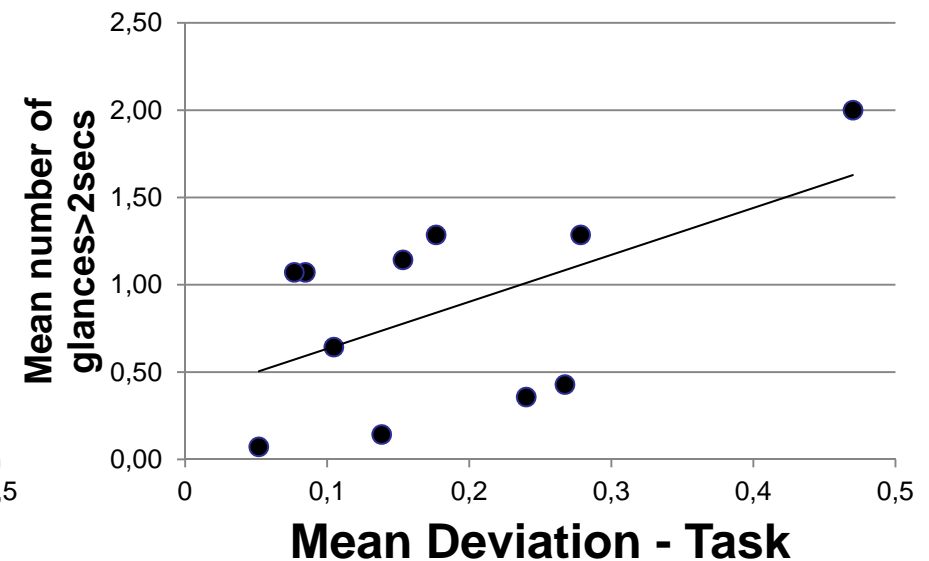




# Use of $Mdev_{Task}$

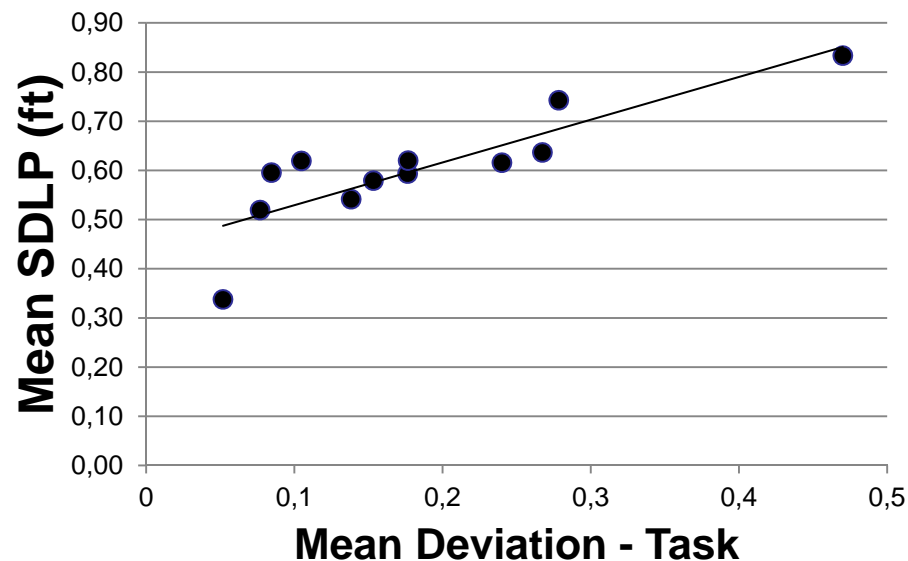


$R=0.94$

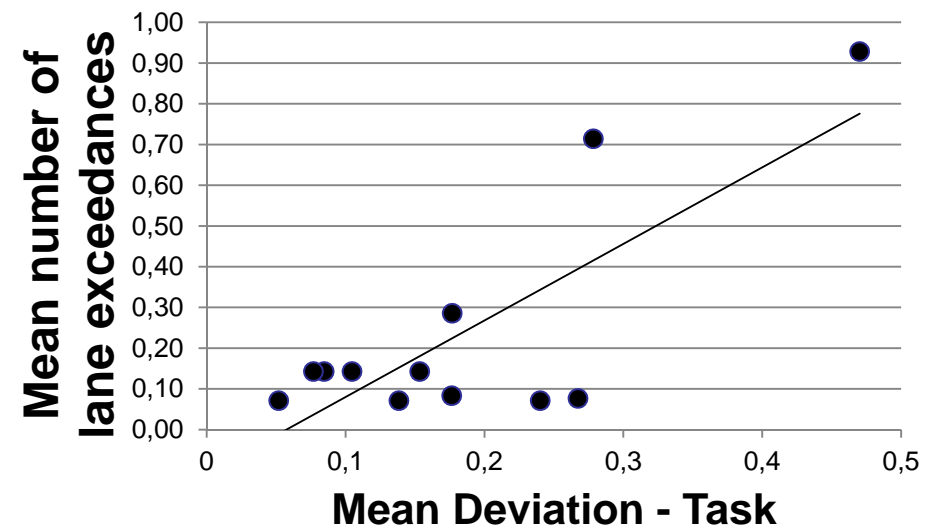


$R=0.55$

# Use of $Mdev_{Task}$



$R=0.85$



$R=0.77$

# Conclusions

- Occlusion (TSOT) has considerably more criterion validity than LCT (Mdev)....
- ...But criterion validity of Mdev is significantly enhanced if converted to  $Mdev_{Task}$  to account for time exposure to risk
- Further work:
  - ◆ Consider a wider range of LCT metrics
  - ◆ Consider a wider range of secondary tasks
  - ◆ Consider other criteria for 'good' methods

# Any questions?

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