Detection Response Tasks:

Using Remote, Headmounted and Tactile Signals to Assess Cognitive Demand While Driving

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OVERVIEW

1. Background
2. DRT ISO Collaborative Research
3. Transport Canada DRT Research
4. Next Steps

1. BACKGROUND

Considerable effort toward developing guidelines & test methods

Goal: minimize distraction arising from interactions with other devices while driving

- Japan Automobile Manufacturers Association Guideline (JAMA, 2004)
- European Statement of Principles on the Design of Human Machine Interaction (ESoP, 2005)
- Alliance Guidelines (2006)
- NHTSA Phase 1 Guidelines Visual Manual (2012)

All focus on **visual-manual demand** from secondary tasks performed while driving

VOICE USER INTERFACES

- In-vehicle interfaces have evolved
- Voice user interfaces much more common

VOICE INTERFACE ADVANTAGES

Hands-free control of certain in-vehicle functions

Facilitates multi-tasking

Require less space than manual controls

Driver performance when using voice interfaces compared with visual-manual interfaces:

> Less time spent looking away from the road

> Driving performance (fewer lane departures,steadier speed)

> Lower subjective workload

VOICE INTERFACE DISADVANTAGES

Voice only interaction is often not truly hands and eyes free

Requires driver attention

Facilitates multi-tasking

Can take more time to perform tasks than conventional modes of interaction

Audio information & speech is transient

Usability problems (e.g., recognition accuracy, non-intuitive, cumbersome…)

Examples ----- awkward interactions, driver frustration, yelling at system….

There are likely to be some Voice interfaces that are better than others

Methods are needed to assess the cognitive demand associated with using voice interfaces while driving

DETECTION RESPONSE TASK (DRT)

Assessment of the effect of cognitive load imposed by performing a secondary task while driving

- Earlier version was “Peripheral/Visual Detection Task”
- PDT → **DRT**: **D**etection **R**esponse **T**ask

- Stimuli repeated (3-5s); artificial; minimally demanding
- Driver responds when stimulus detected

DETECTION RESPONSE TASK (DRT)

- Baseline where there is no secondary task is compared with condition where secondary task is performed
- **Logic:** To the extent that the additional secondary task is demanding, performance on the DRT is affected
- Longer DRT latencies indicate increased workload; also detection rate may be reduced

2. ISO DRT COLLABORATIVE RESEARCH

GOAL: Investigate the DRT in the assessment of cognitive demand from secondary tasks while driving

Research to support standard development

ISO TC22 SC13 WG8 (Ergonomics applicable to Road Vehicles/ HMI) 17488

> Focus is assessment of **auditory/speech tasks**

RESEARCH COLLABORATIONS ON DRIVER MEASUREMENT USING DRT: ISO 17488 DRT

Partners:

- Volvo (Sweden)
- TNO (The Netherlands)
- IFSTTAR (France)
- TU Munich (Germany)
- US labs: Wayne State, DRI
- Transport Canada
- Malaysian Institute of Road Safety Research (MIROS)

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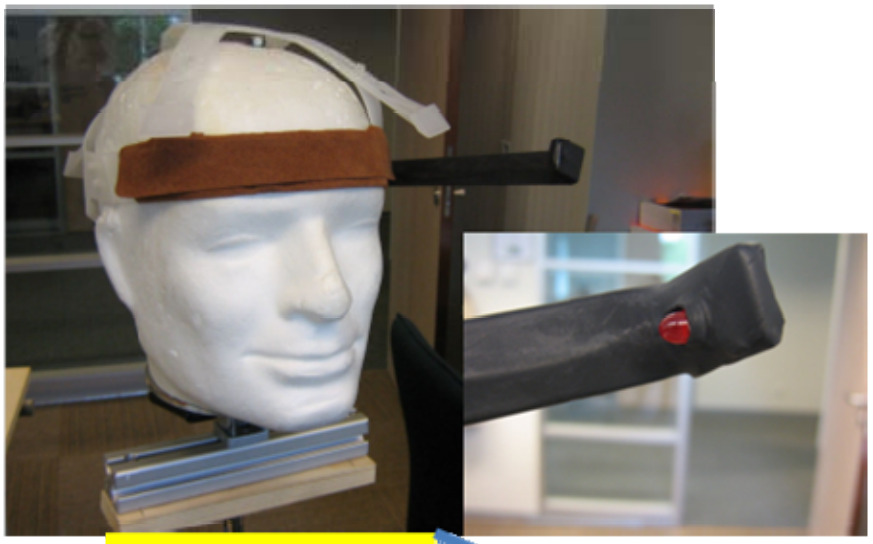
RESEARCH APPROACH:

- Matrix of experiments across labs to leverage research productivity
- A common minimum set of materials used
- Experimental environments: Non-driving, surrogate driving, simulator & on-road
- All used Tactile DRT; many labs included other versions as well

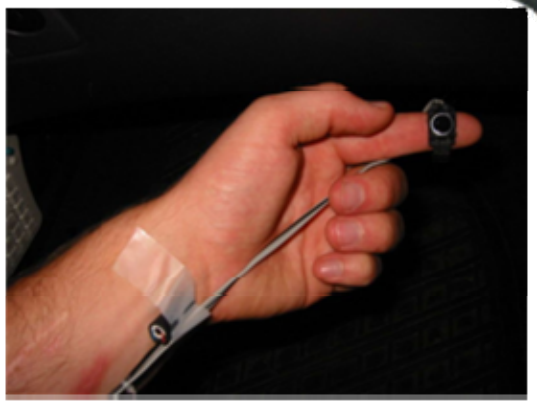
METHODS OF PRESENTING THE STIMULI



Head Mounted

In the Driving Scene

Tactor on Skin



Response made by pressing finger switch

3. TRANSPORT CANADA RESEARCH

Extension of NHTSA's Distraction Guidelines to cover speech-based interfaces

Test methods are needed to assess distraction that can arise from these auditory/speech interactions

Two Main Questions:

Q1: Sensitivity of DRT to levels of cognitive demand?

Q2: Which version of the DRT is better suited to detect cognitive distraction (as in voice interfaces)?

TRANSPORT CANADA STUDY: METHOD

- 16 participants (21-46); 8 male, 8 female
- NADS MiniSim fixed base simulator
- Moderate curvature, 100km/h speed
- Ambient traffic with no interaction; instructed to stay in right lane
- Instructions: "Your main priority is to drive safely. Please do your best to pay attention to the detection tasks and the secondary tasks as we are interested in your performance on both of these as well."

Logic of the approach:

- Use tasks with known manipulated levels of cognitive demand
- Investigate some real world tasks as well

TASK CONDITIONS

Baseline: no secondary task; drive & DRT

Secondary Auditory /Verbal Tasks: [tasks 1 minute; 30 s between tasks]

N-back: 0, -1 [artificial task]

0-back

I say:	3	2	6	7	1
You Say:	3	2	6	7	1

1 back

I say:	3	2	6	7	1
You Say:		3	2	6	7

N BACK 1

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TASK CONDITIONS

SIRI [iPhone speech interface]

1=question list (Volvo)

2=speech email reader & make calendar entry using voice

(no specific prediction of difficulty)

SIRI 1

Questions posed to Siri
Participant asks: What time is it? What is today's date? What's the temperature outside? Will it rain today? Will it be sunny on Friday? What's on my calendar for Friday? What day of the week is the 20th? Set an alarm for 8 am. What date is it on Saturday? Turn off the 8 am alarm.

SIRI 2

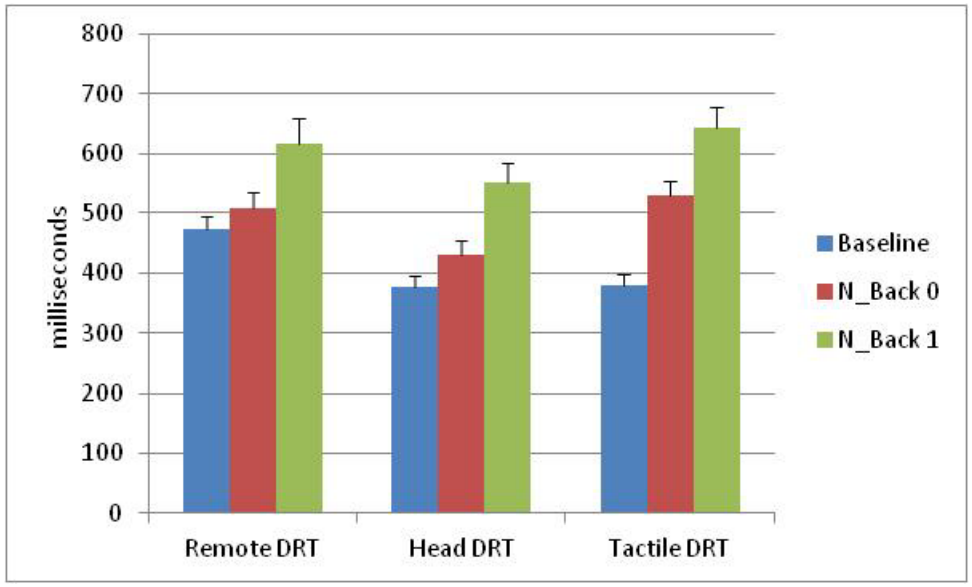
Read Text Message & Make Calendar Appointment
Participant says: "Read me my text" Siri says: "Your dentist appointment is Monday at 3. Your doctor appointment is Wednesday at 11. Make 2 entries in your calendar." Participant says: "Schedule appointment Monday at 3. Schedule appointment Wednesday at 11."

RESULTS:

Hit Rate (Detections)

- Not the primary measure of interest
- Hit Rates exceeded 80% in all conditions

N-BACK TASKS: REACTION TIMES



- RTs increase as task difficulty increases

- TACTILE DRT
  - Sig greater increases 3 conditions
- HEAD DRT
  - N-1 sig greater than other conditions
- REMOTE DRT
  - N-1 sig greater than other conditions

** sensitivity of TACTILE DRT

Mean Reaction Times (+ SE) for the N-Back Tasks for Each Version of DRT

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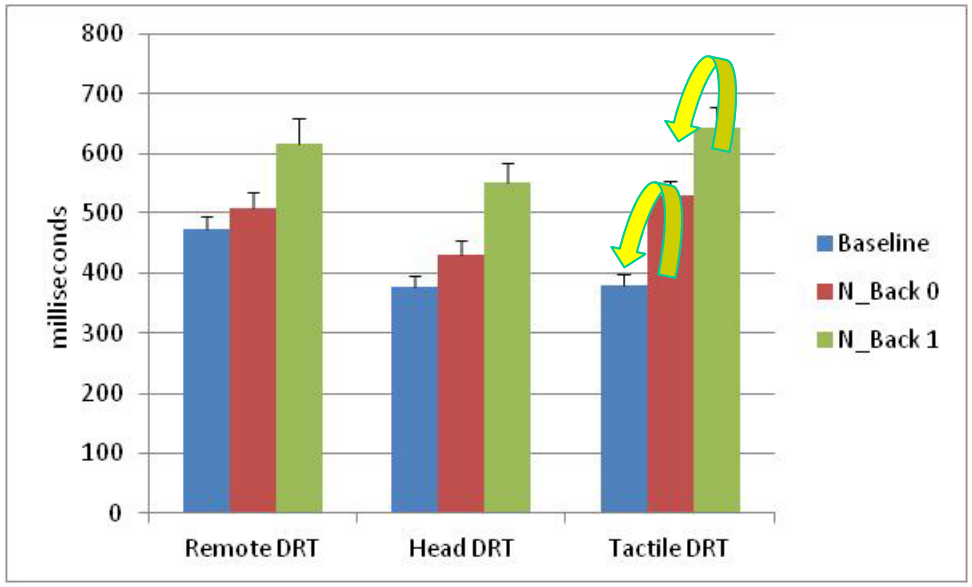
N-BACK TASKS: REACTION TIMES



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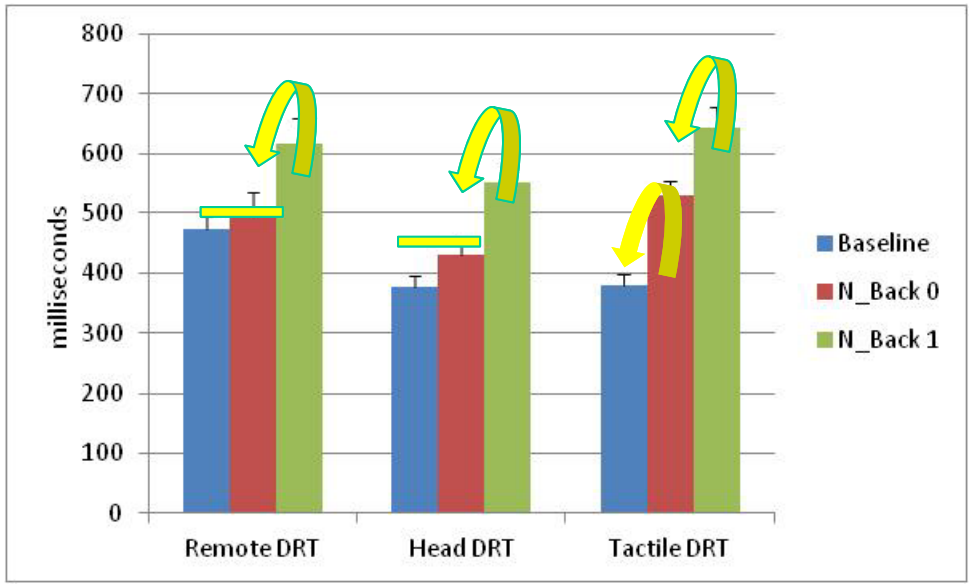
N-BACK TASKS: REACTION TIMES



- Generally, RTs increase as task difficulty increases

- TACTILE DRT
  - Sig greater increases 3 conditions

- HEAD DRT
  - N-1 sig greater than other conditions

- REMOTE DRT
  - N-1 sig greater than other conditions

**** sensitivity of TACTILE DRT**

Mean Reaction Times (+ SE) for the N-Back Tasks for Each Version of DRT

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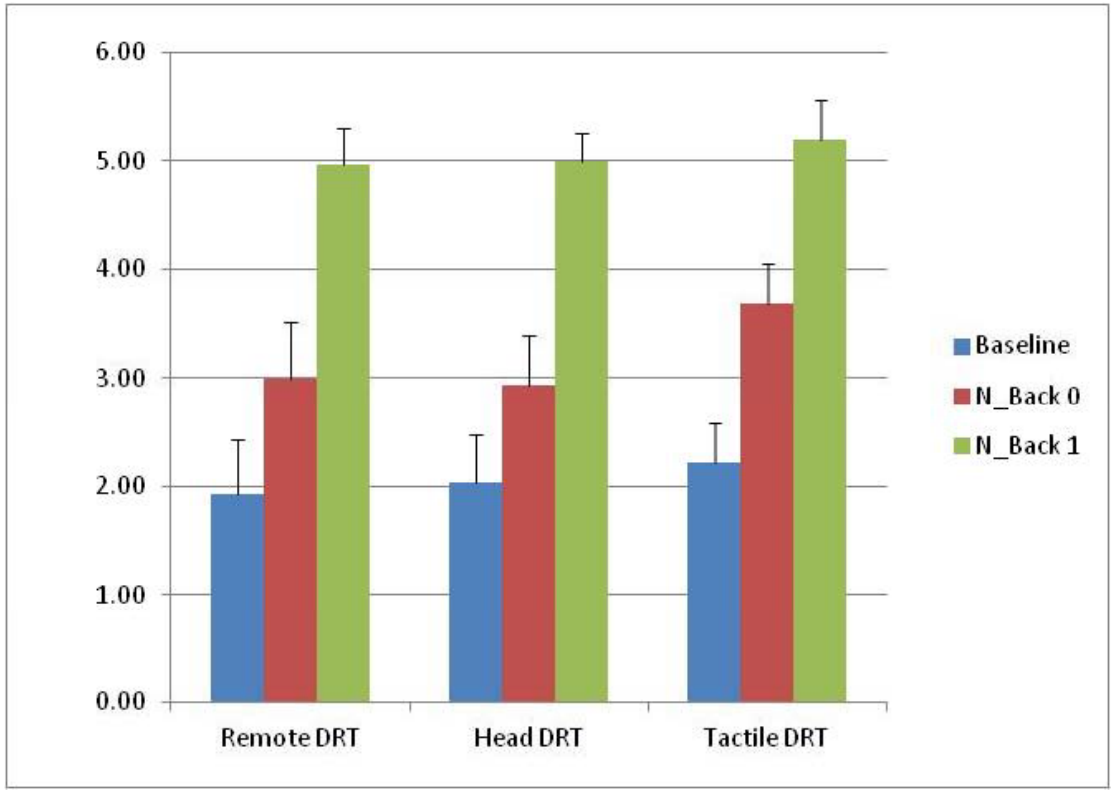
WORKLOAD RATINGS: N-BACK



Workload Ratings increased across the three conditions of No Task, N-Back 0 and N-Back1 for all three versions of the DRT (all pairwise comparisons significant).

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SUMMARY FOR RT DATA

- N BACK 0 & 1 distinguished by all 3 DRT methods
- Only Tactile discriminates all tasks from baseline and from each other

SIRI: QUESTIONS

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SIRI: READ TEXT / MAKE CALENDAR ENTRY

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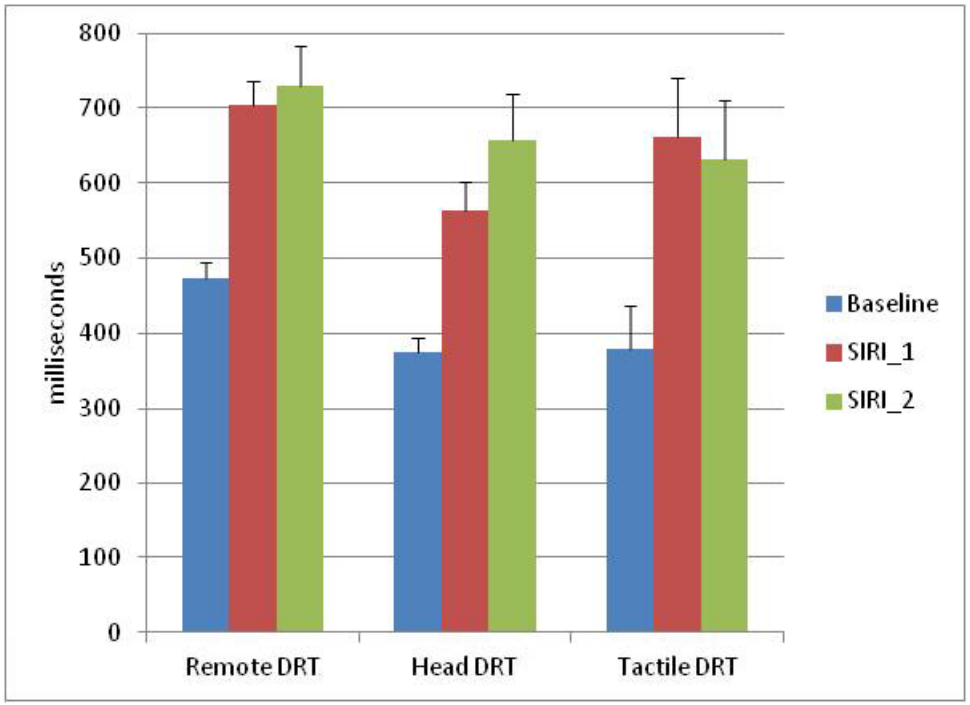
SIRI TASKS: REACTION TIMES



All 3 DRT versions, SIRI tasks result in longer RTs

For Head DRT two SIRI tasks differ

•No predictions about SIRI task difficulty

•Further analyses planned to investigate individual questions vs email/calendar task

Mean Reaction Times (+ SE) for the SIRI Tasks for Each Version of DRT

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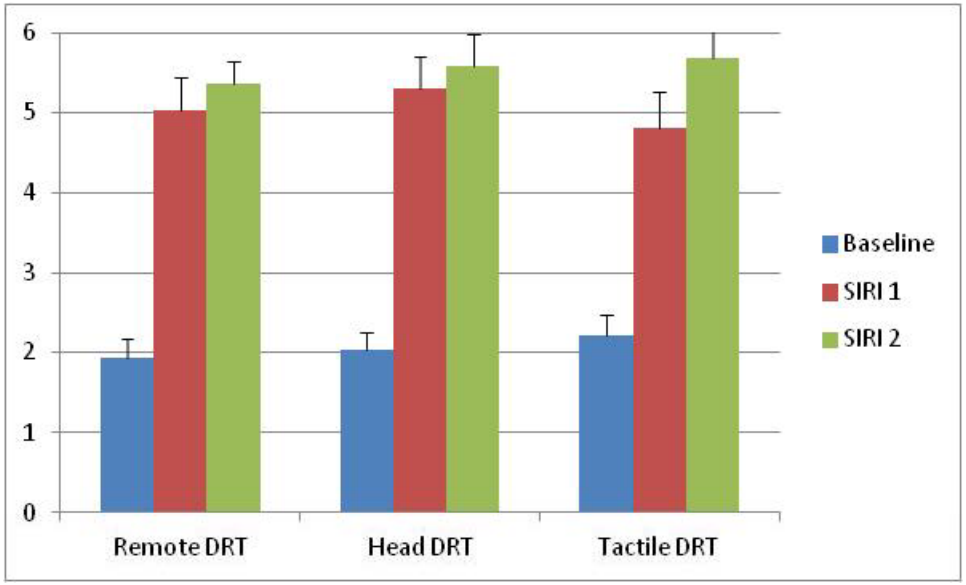
WORKLOAD RATINGS: SIRI



2 SIRI tasks rated as more demanding than baseline
Only for Tactile DRT do the ratings for the 2 Siri tasks differ

SUMMARY

DRT is intended to assess cognitive demand in the context of driving

Q1: Sensitivity of DRT to level of auditory/speech task demand?

N-Back task results indicate that all 3 DRT versions were sensitive to cognitive demand but only the Tactile DRT distinguished the increase from Baseline

SUMMARY…

Q2: Which version of the DRT is better suited to detect cognitive distraction (as in speech interfaces)?

All 3 DRT were sensitive to cognitive demand

Important Considerations:

1. Remote DRT can be difficult to implement; Tactile & Head much easier & portable; use in vehicles
2. Important **limitation of Remote DRT** is that it is also affected by visual distraction such as when driver is looking away from forward view they cannot detect stimuli

SUMMARY…

Head & Tactile DRT are always “with the participant”

3. Tactile DRT has advantage over Head DRT since it can be used with eyetracking equipment without interference

Newer variants of the DRT are useful tools to assess cognitive distraction

4. NEXT STEPS

- Work in progress
- ISO collaborative research:
  - Further analyses of dependent measures
  - Cross lab analyses & comparisons (lots)
- Current status is working document v9.2
- ISO Standard: ISO 17488- June 2013

- New Research ongoing

Thank you for your attention!

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Driving and Speaking: Revelations by the Head-Mounted Detection Response Task (56) Conti, Dlugosch, Schwartz & Bengler

Comparison of Static and Driving Simulator Venues for the Tactile Detection Response Task (57) Engström, Larsson & Larsson