MONASH University
Accident Research Centre

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The impact of interface modality on police officers' visual behaviour when using an in-vehicle system

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Outline

- Off road glances while driving
- Work in police vehicles
- Driving simulator and study design
- Results
- Discussion
- Considerations for future research
- Implications

Off road glances

- In-vehicle information systems (IVIS)
  - Division of attention
- Unexpected events occurring when driver's is not looking result in crashes or near misses. (Dingus and Klauer 2008).
- Glance behaviour included in guidelines for good IVIS design. e.g. AAM, 2002; ISO, 2006; SAE, 2000
  - Self paced
  - Easily interruptible
  - Required glances ≤ 2 seconds

Safety critical glance duration

Crashes occur during “atypical” situations

- The majority of off road glances required for driving are < 2s (check odometer 0.98s, check rear-view mirror 1.63s).

(Sodhi et al. 2002)

- The majority of glances to an IVIS during a standard (GPS) task will be < 2 seconds.

(Chiang et al. 2004)

> 2 seconds off road glances

- Linked to increased risk of crash/near crash.

(Dingus and Klauer 2008, Klauer et al. 2006)

- Impairs vehicle control.

(Ryu et al. 2013)

Work in Police Vehicles

Work in Police Vehicles

Work in Police Vehicles

Drivers are advised not to use MDT when driving

- Observation and subjective report suggests interaction does occur.

  (e.g. Hampton and Langham 2005)

- Licence plate search while maintaining visual contact.

  (Marcus and Gasperini 2006)

- Using an MDT – most common in-vehicle activity.

  (Mckinnon et al. 2011)

- 22.3% of police driving time is with a single arm controlling the steering wheel.

  (Mckinnon et al. 2011).

Method

Participants

19 experienced drivers of police vehicles

	Mean	Standard Deviation
Age	47.2y	6.8y
Worked for NSW Police Force	18.0y	8.4y
Hours per week in a police vehicle	20.7h	9.2h

Simulator

Simulator

Simulator

Four scenarios

- 6.6km of urban road
- Approx. 10 min to complete
- Straight and undivided.

Participants instructed to drive as normal, taking into consideration the speed limit and other road users.

Drive in the left hand lane unless directed by road signs to change lanes or turn.

Simulator

Design

Counterbalanced four experimental conditions

- Baseline
- Visual-Manual
- Visual-Voice
- Audio-Voice (simulated voice recognition)

Participants completed a practice drive and practiced each secondary task prior to data recording.

Each session lasted approximately 90 minutes.

Eye tracking measures

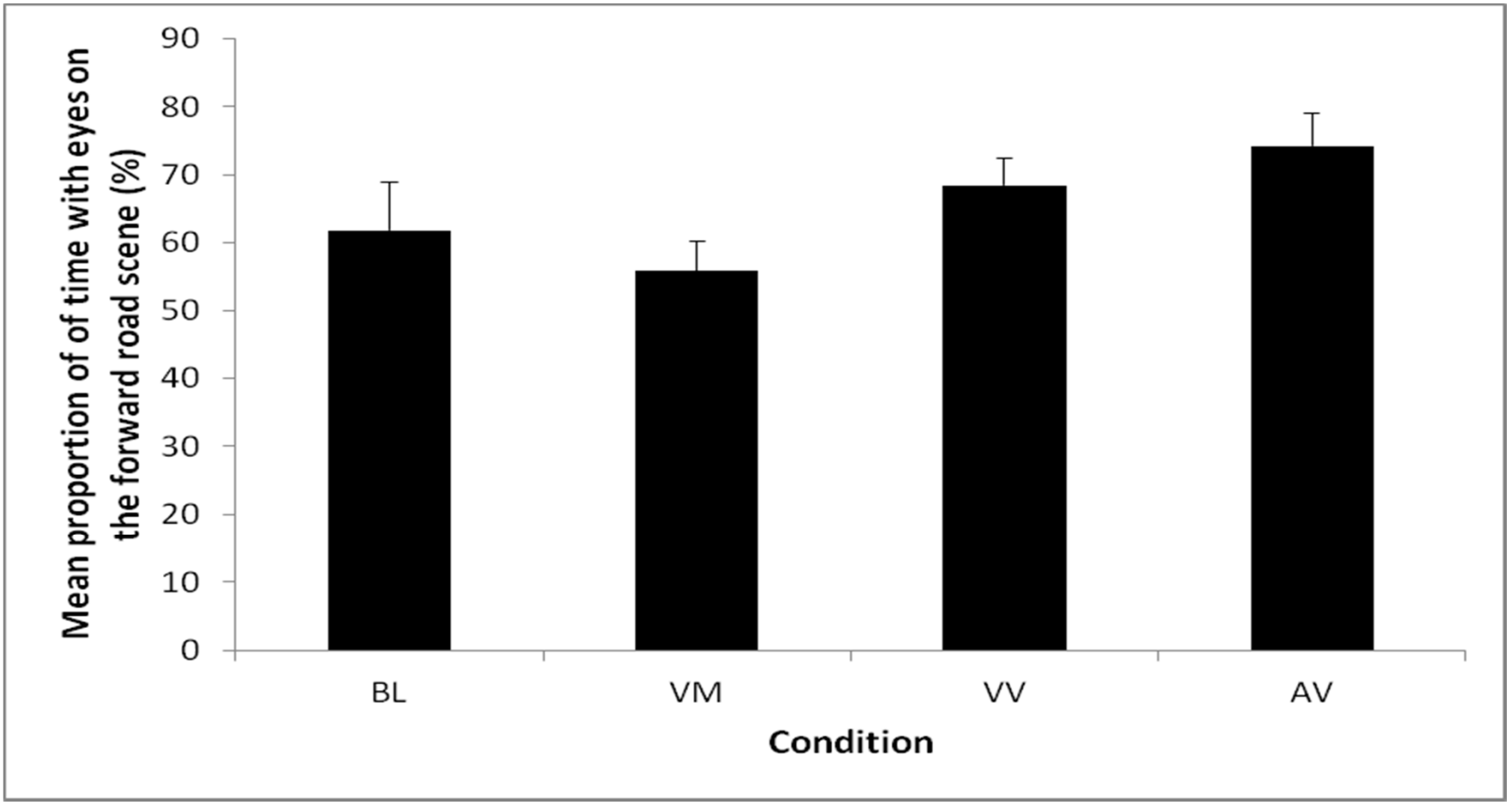
- Percentage of total gaze time on the road. (±10 degrees in the horizontal plane and ±5 degrees in the vertical plane, from the centre of the road)
- Percentage of total gaze time on the display screen. (an adjusted location for each participant 10 degrees (horizontal) by 10 degrees (vertical))
- Number of glances towards the display screen. (glance = uninterrupted fixation to display screen minus saccade transition time).
- Mean number of glances per completed task.
- Mean glance duration per completed task.
- Glance duration distribution. (<1s, 1-2s and >2s)

Results

16 participants

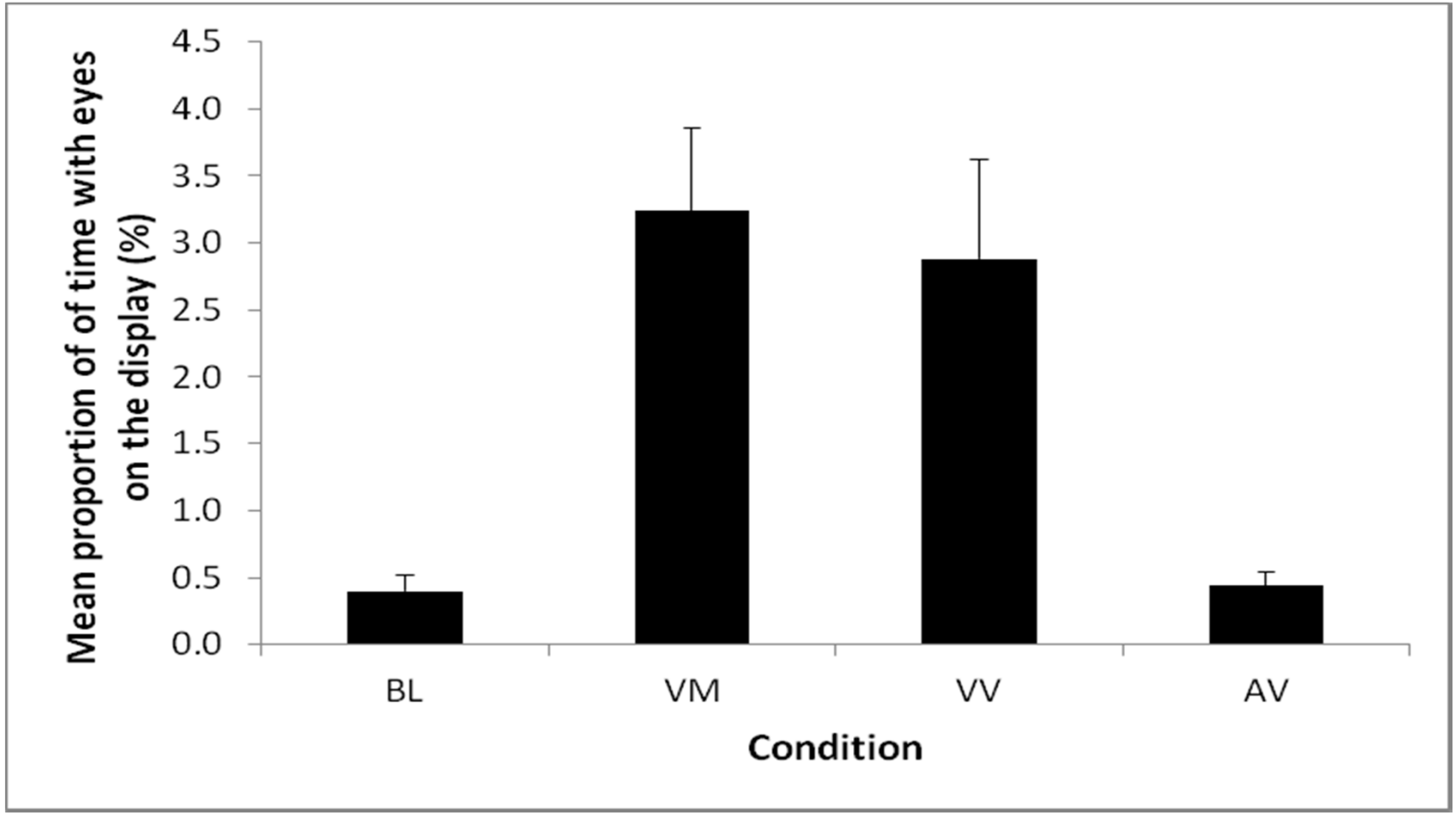
	Visual-Manual	Visual-Voice	Audio-Voice
Secondary task accuracy	59.2%	72.1%	54.1%

Results - eyes on the forward road scene



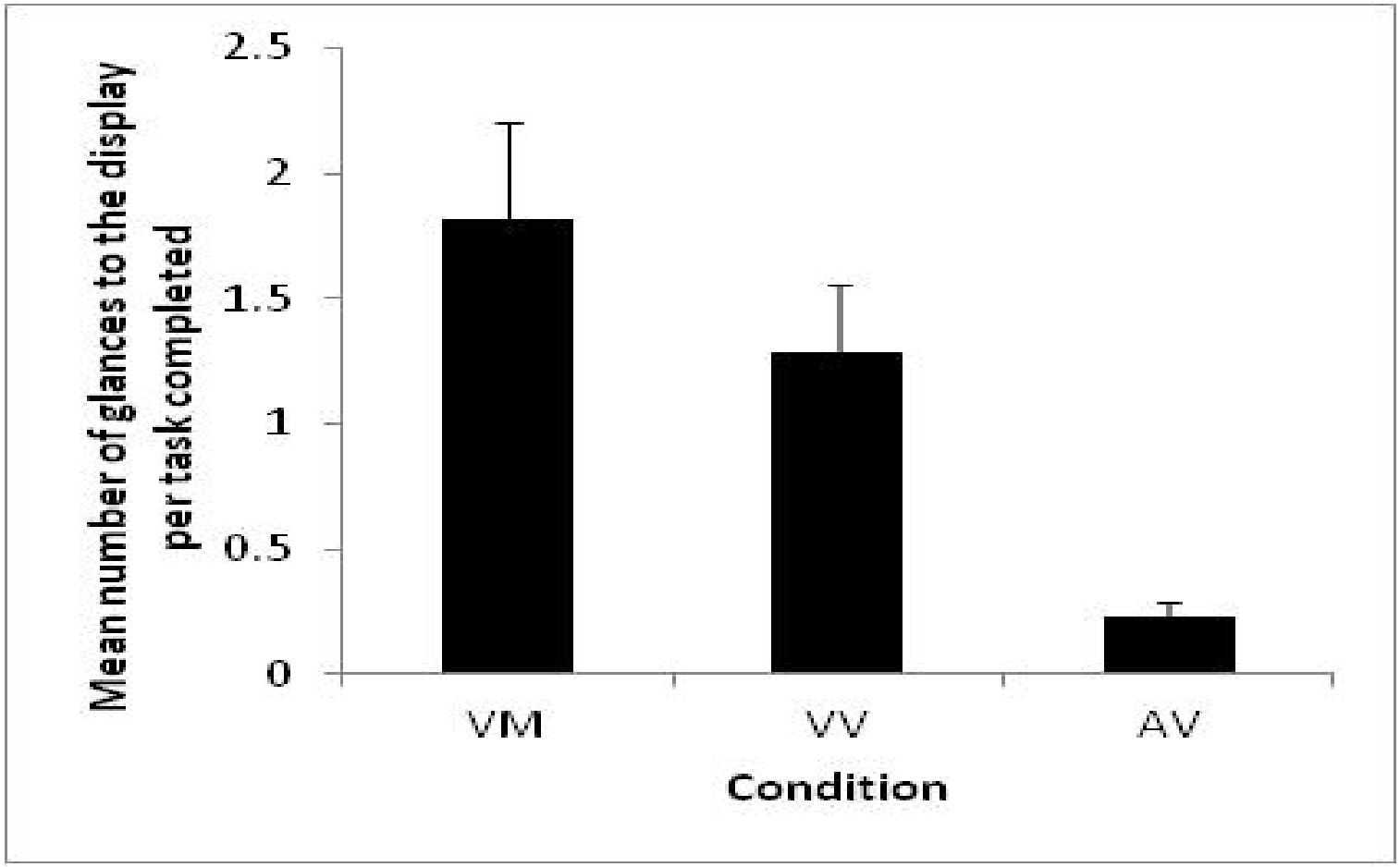
$F(3,45) = 7.60$, $p<0.001$

Results - eyes on display



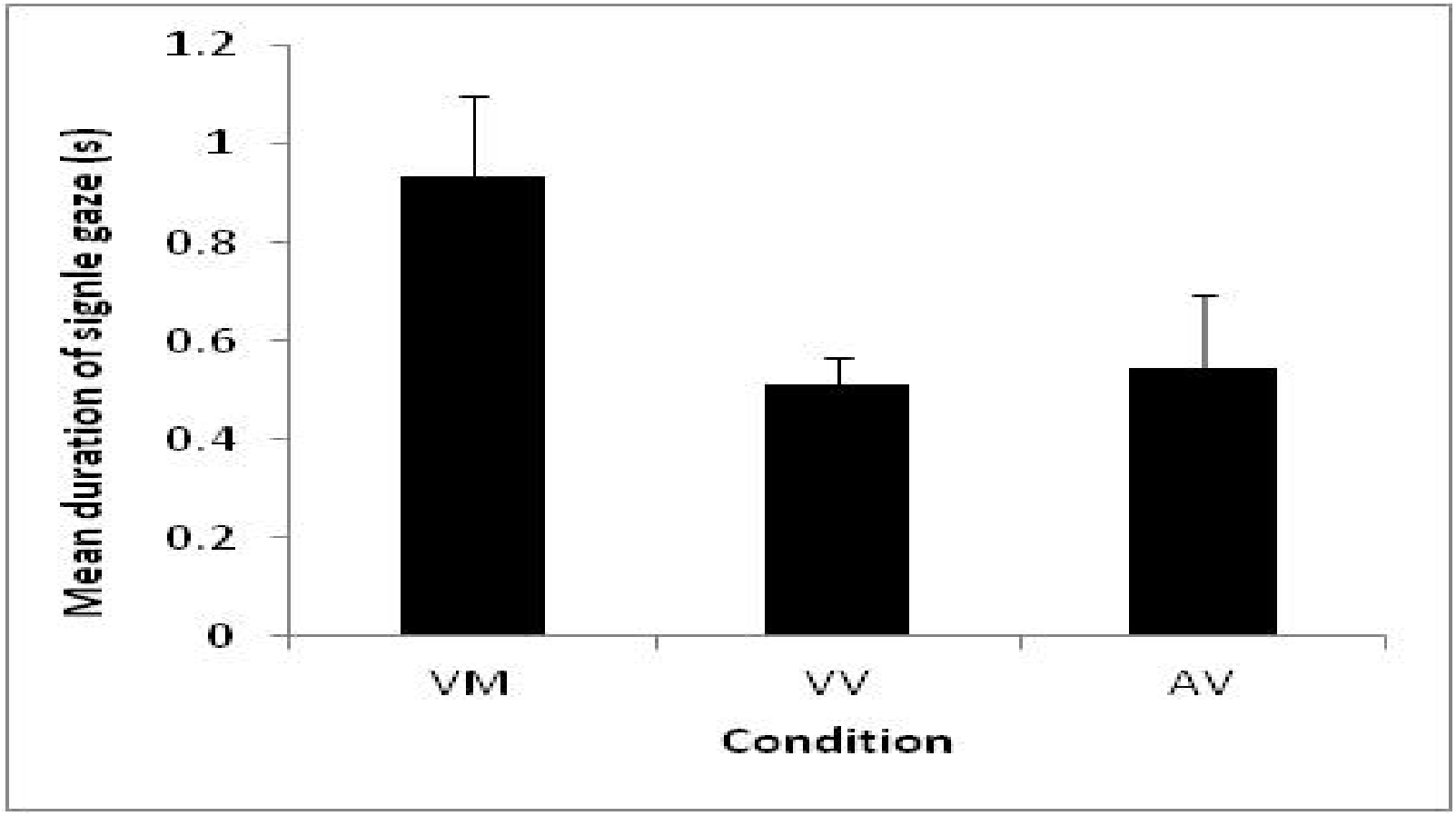
F (2,29) = 11.75, p<0.001

Results – number of glances per task



F (2, 30) = 12.242, $p < .001$

Results – mean glance duration per task



F (2, 30) = 3.528, $p < .05$

Distribution of glance duration

	< 1s glance duration	1 -2s glance duration	>2s glance duration
Total	739	125	32
VM	35.2%	52%	68.8%
VV	48.0%	40.8%	18.8%
AV	9.1%	3.2%	6.3%

Differences compared to baseline

	BL to VM	BL to VV	BL to AV
Total glances	↑ **5.4 times***	↑ **6.4 times***	↑ 1.1 times
< 1s glance duration	↑ **4.6 times***	↑ **6.2 times***	↑ 1.2 times
1-2s glance duration	↑ **13 times***	↑ **10.2 times***	↓ 0.8 times
>2s glance duration	↑ **11 times***	↑ 3 times	No change

*** p≤0.001**

Discussion

- MDT interface modality has implications for driver distraction.

- Traditional MDT interface – **Visual-Manual** resulted in:
  - Less time looking at forward road.
  - More and longer glances per task completed.
  - The greatest proportion of > 2s glances.
  - 11 times more > 2s glances than baseline.

Discussion

Visual-Voice interface resulted in:

- More glances towards the display than Visual-Manual

HOWEVER:

- Overall greater total eyes on the road time compared with Visual-Manual.
- Similar number of glances per task occurred although of significantly shorter duration.
- Greater accuracy in task completion.
- Greater increase in short glances (<1s) than Visual-Manual.
- **No significant increase in number of safety critical glances (>2s).**

Discussion

Audio-Voice interface resulted in:

- No significant difference from baseline, maintained eye glance behaviour.

Considerations for future research

- Precise definition of safety critical glance.
- Influence of other factors on safety critical glance, e.g. presentation of information, ease of use, participant demographics, **pressure from current situation – police chase, single or multiple occupancy…**

Considerations for future research

- Audio-Voice technology
  - Ambient noise considerations in on-road police vehicles.
  - Practical implementation e.g. headset wearing, navigation of menus.
  - Accuracy – important for police, Visual-Voice had highest accuracy.
  - Cognitive load distraction.

Implications

- MDTs are important to police work and have improved productivity.

(Hampton and Langham 2005)

- Single vs multiple occupancy vehicles.
- Dangers associated with using MDT while driving.

Enhancement of interface modality has potential to go someway in mitigating the distracting consequences of operating an MDT.

  – Development and use of a voice-based interface.

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Thank you for listening

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Questions?