Examination of drivers' cell phone use behavior at intersections by using naturalistic driving data

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UMTRI

Introduction

- Driving simulator studies of cell phone-related distraction
  - Driving performance decreased and crash risk assumed to increase (Drews, et al., 2009; Liang & Lee, 2010)
  - Decrements in lane-keeping, increases in speed variability (*Crisler, et al., 2008*)
  - Increases in following distance variability (*Hosking, et al., 2009; Owens, et al., 2011*)
- Survey study of cell phones and safety
  - Cell phone use steadily increased while crash rates declined during the same time period (Insurance Institute for Highway Safety, 2010).

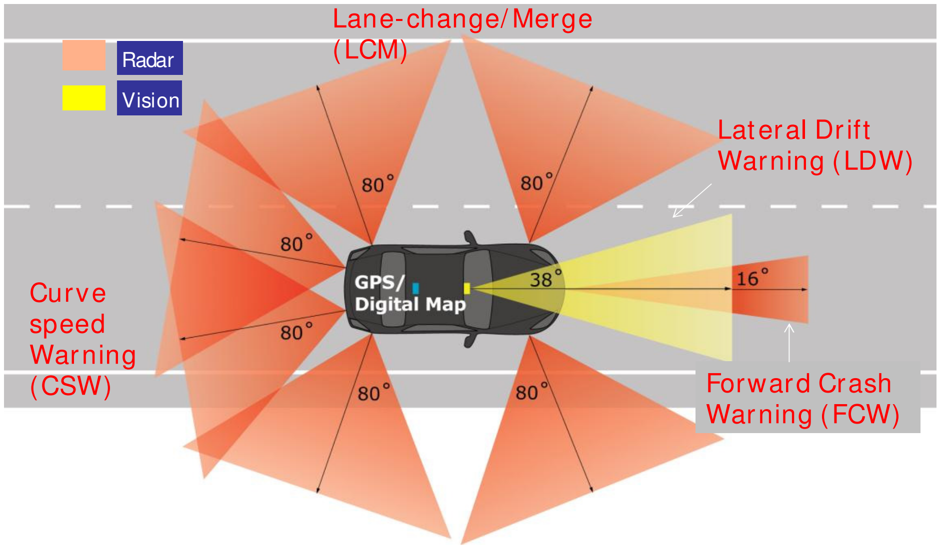
Research Question

- How driver behave when they use cellphone
  - Naturalistic driving environment
  - Specific scenario: go through signalized intersections
  - Driving performance: speed
  - Situational factors: lighting conditions, traffic conditions

Data Resources: IVBSS

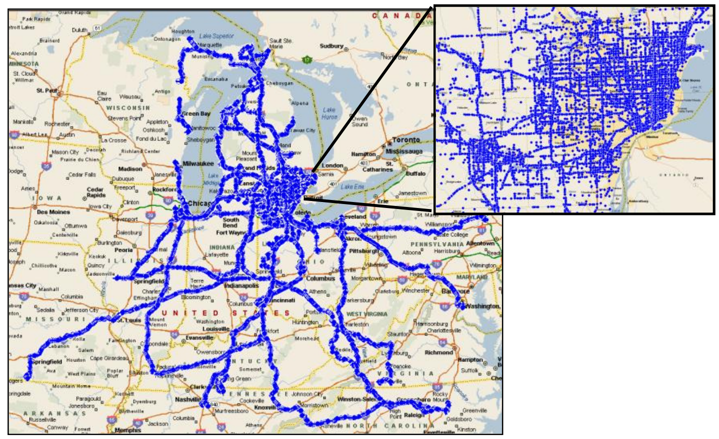
- Naturalistic driving data from Integrated vehicle based safety system (IVBSS) program
  - 5-year long program
  - Integrated four types of warnings FCW, LDW, LCM, and CSW
  - 16 instrumented research vehicles (2006 Honda Accord)
  - 108 drivers (6 weeks of driving for each)
    - **Younger drivers (M=25.2; SD=2.9)**
    - **Middle-aged drivers (M= 46.0; SD=3.0)**
    - **Older drivers (M= 64.6; SD=2.8)**

IVBSS: Instrumented vehicles

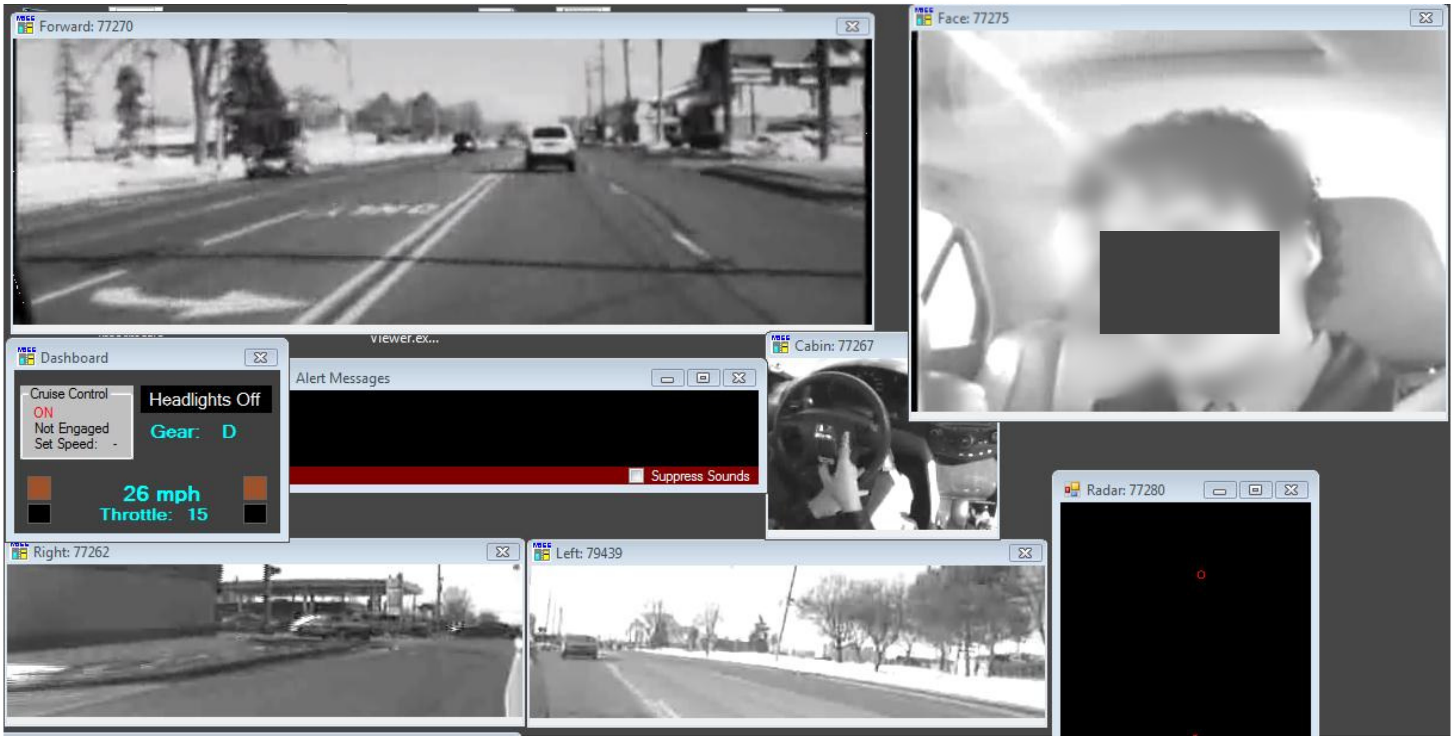


IVBSS: Data Collection

- April 2009 to April 2010
- Data from 108 drivers
- Data Set
  - Over 213K miles
  - 23K trips
  - 6,200 hours
  - 600 data channels
  - 5 video channels



IVBSS: Video Data



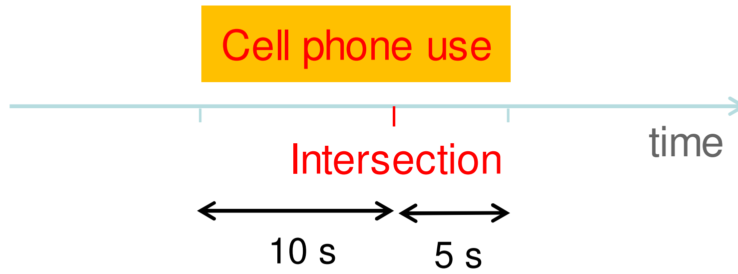
Trained coders went through one week video data, 1381 conversations, 2149 Visual/Manual (VM) tasks

Method

- Case Control Study
  - Case: went through signalized intersections
  - Control: match on the same driver and intersection
- One way ANOVA
  - Test average, maximum and minimum driving speed between cell phone use and baseline (driving only)
- Mixed model
  - Dependent variable: average speed
  - Explanatory variables: traffic condition and lighting condition (situational factors), cellphone use condition

15 s Samples for Going Through Signalized Intersections

- Signalized intersections were identified based on HPMS data base
- Baselines were matched based on driver and intersection
- Min speed over 15 s (10s before the intersection + 5 s after) > 8.9 m/s=20mph
- Conversation (453), baseline (647)
- VM (141), baseline (149)



Results: Conversation

- ANOVA for conversation and baseline
  - Significant differences on max and mean speed
  - No significant differences on minimum speed
  - The differences were small (but over 15 seconds of driving)

Speed	Difference m/s (mph)	p-value
Maximum	0.67 (1.50)	<0.001
Mean	0.43 (0.96)	0.05
Minimum	0.22 (0.49)	0.35

Results: Conversation (Cont.)

- Mixed model showed the consistent results
  - Drove slower with conversation
  - Lighting situation not significant
  - Significant interaction between traffic and conversation

Factors	Estimates	SE	p-value
Intercept	18.33	0.38	<0.01
Conversation	-0.67	0.24	<0.01
Moderate traffic	-0.74	0.24	<0.01
Dense traffic	-0.53	0.33	n.s.
Conversation : Moderate traffic	0.11	0.31	n.s.
Conversation : Dense traffic	1.12	0.54	0.04

Results: Conversation (Cont.)

- ANOVA for each traffic condition
- Sparse and moderate had similar pattern, lower speed with conversation compared with baseline
  - Relative balanced sample size
  - Sparse: $\Delta_{B\text{-}C}$=0.43 m/s, p=0.02
  - Moderate: $\Delta_{B\text{-}C}$=0.67 m/s, p=0.005
- Dense had opposite pattern, higher speed with conversation
  - $\Delta_{B\text{-}C}$=-0.75 m/s, p=0.43
  - 47 conversation (10%), 107 baseline

Results: VM Tasks

- ANOVA for VM tasks and baseline
  - Significant differences on max and mean speed
  - No significant differences on minimum speed
  - The differences were greater

Speed	Difference m/s (mph)	p-value
Maximum	1.36 (3.04)	0.005
Mean	1.24 (2.77)	0.004
Minimum	0.84 (1.88)	0.9

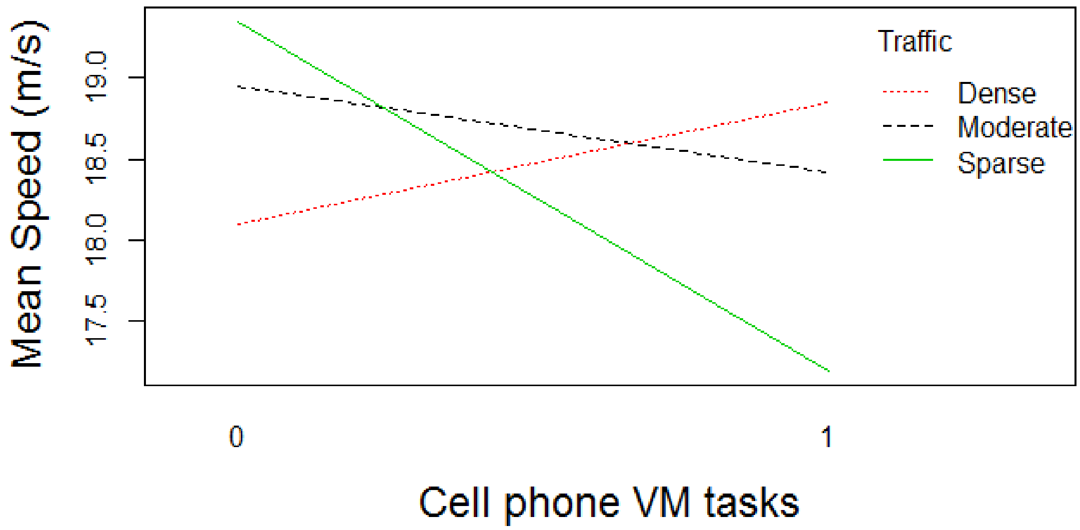
Results: VM Tasks (Cont.)

- Mixed model showed the consistent results
  - Drove slower with VM tasks
  - Lighting situation not significant
  - Significant interaction between traffic and VM tasks

Factors	Estimates	SE	p-value
Intercept	18.97	0.58	<0.01
VM tasks	-1.76	0.49	<0.01
Moderate traffic	0.27	0.57	n.s.
Dense traffic	-0.72	0.80	n.s.
VM : Moderate traffic	0.79	0.79	n.s.
VM : Dense traffic	2.54	1.08	0.02

Results: VM Tasks (Cont.)

- Sparse and moderate: lower speed with VM tasks
  - Sparse: $\Delta_{B\text{-}T}$=2.15 m/s, $p<0.01$
  - Moderate: $\Delta_{B\text{-}T}$=0.53 m/s, $p=0.1$
- Dense: higher mean speed with VM tasks, $\Delta_{B\text{-}T}$=-0.74 m/s, $p=0.46$, 18 VM



Discussion

- Adapted behavior
  - Reduced speed more with VM vs Conversations
    - **Adapt their behaviors to compensate for higher driving demand**
  - Significantly much lower speed with VM tasks under sparse traffic
    - **Drivers engage in VM tasks in low demand situations (sparse traffic)**
    - **Reduced speed as well to compensate for the increased demand from secondary tasks**

Discussion

- Adaptive behavior
  - **Speed increase but not significant with cellphone use under dense traffic**
    - **Few cellphone use events under dense traffic, drivers might avoid to use cellphone under high driving demand situations**
    - **Two participants contributed most of cellphone use events, might be risker drivers**
    - **Maintain traffic flow which might cause increased driving demand**
    - **Further examinations are needed with larger sample size**

Future Work

- No critical situations occurred in this one week driving duration
- Future analysis could focus on safety critical events, such as crash or near crash events

Questions?

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