Naturalistic Studies of Driver Assistance System Use

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Topics

- Discuss UMTRI's experience in naturalistic driving studies
- How naturalistic evaluation of systems differs from other naturalistic studies
- Discuss some tools and techniques UMTRI has developed and deployed
- Show some interesting findings

UMTRI's Naturalistic Experience

- All, to date, have been associated with evaluating new technologies
  - ABS, adaptive cruise, crash warning systems
- Baseline periods or controls
  - Matched fleets or a within-subject design
  - Need to create a "before" and "after"
- Not strictly naturalistic driving
  - But baseline periods, in particular are close

UMTRI's Naturalistic Experience

1993 – 1995	Long Combination Truck ABS and C-dollie	Naturalistic	870K mi
1996 – 1997	108 subjects, 2-5 weeks each, passenger cars, manual, CCC, ACC/ no braking	Naturalistic	114K mi
2000 – 2001	30 heavy truck drivers, 12 months, manual, roll stability advisory	Naturalistic	1.2M mi
2003 - 2004	96 subjects, 4 weeks each, passenger cars, manual, CCC, ACC/braking, FCW	Naturalistic	140K mi *
2004 - 2005	78 subjects, 4 weeks each, passenger cars, manual, curve speed and lateral drift warning	Naturalistic	83K mi *

* Most recent data sets contained in meta-data relational databases

Naturalistic Systems Evaluation

- Very specific questions to be addressed
  - Evaluate the performance and use of new technologies
    - "How does adaptive cruise control influence headway?"
  - Instrumentation is specifically focused
    - Sensor selection often dictated by the system design
  - Both with and without the users' vehicles
    - Level of modification/instrumentation can prohibit using the consumer's vehicle

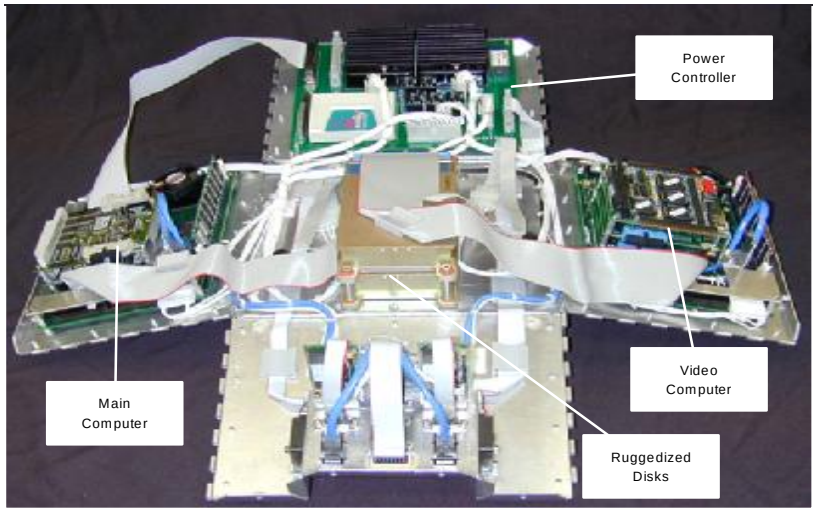
Naturalistic Systems Evaluations

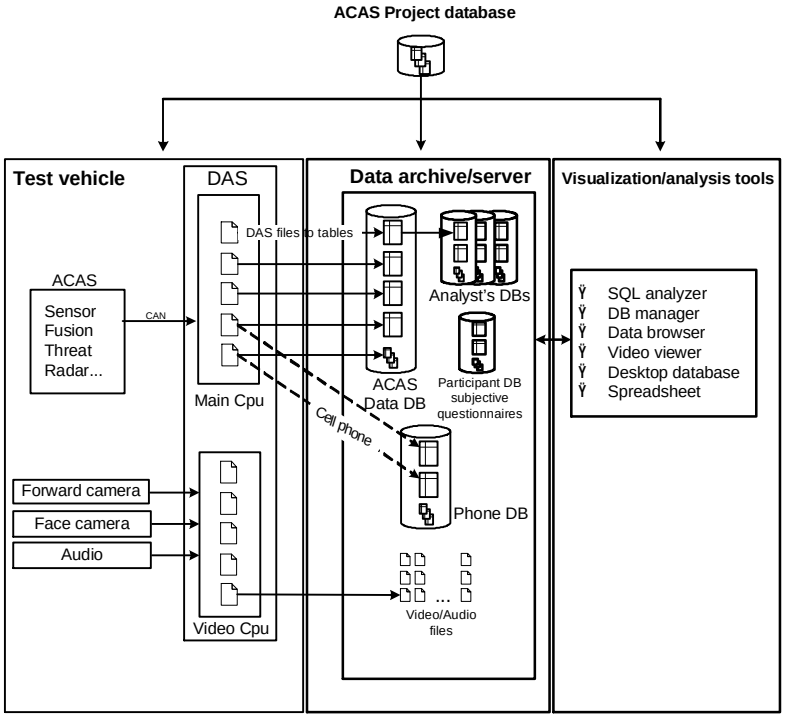
- Maintaining levels of control
  - How representative is the sample
    - There will always be the potential of sampling bias
    - Age, gender, roadway environment
  - Seasonal variations
    - Sensing lane position can be difficult in Winter
  - Vehicle variations
    - System performance, ability to install systems, and the possible affect on the driver (i.e., vehicle familiarity)

UMTRI Tools and Techniques

- Multi-generational data acquisition and database management systems
  - Progressively increase the performance capabilities of the data acquisition systems
  - Packaging gets smaller
  - Costs stay about the same
- The amount of data has increased 10x
- Database size and capability must keep up
  - 3 second rule

UMTRI Tools and Techniques





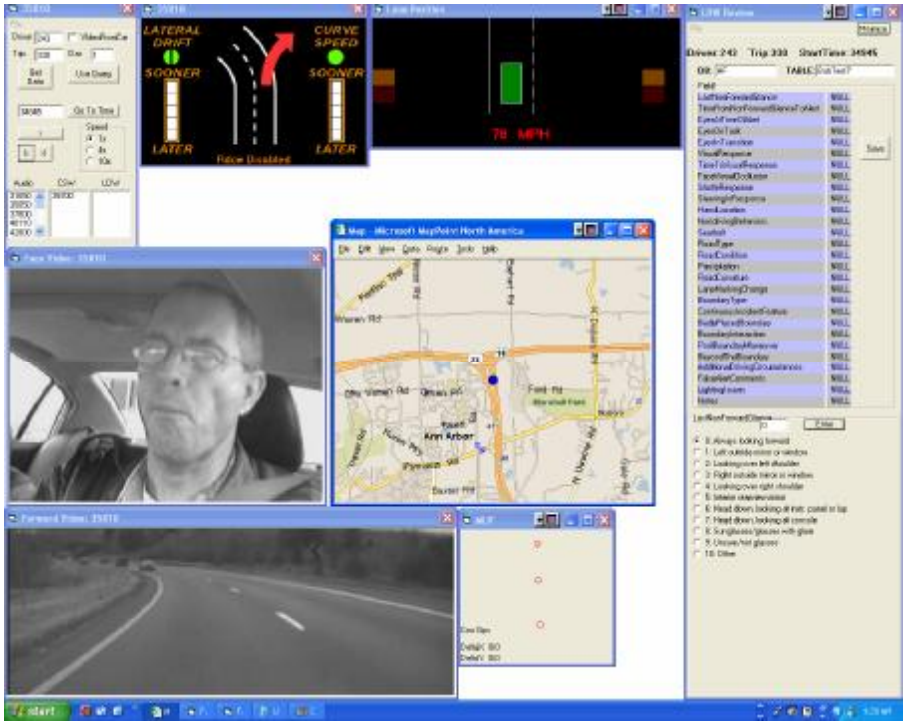
250K miles of naturalistic use
96% data success rate

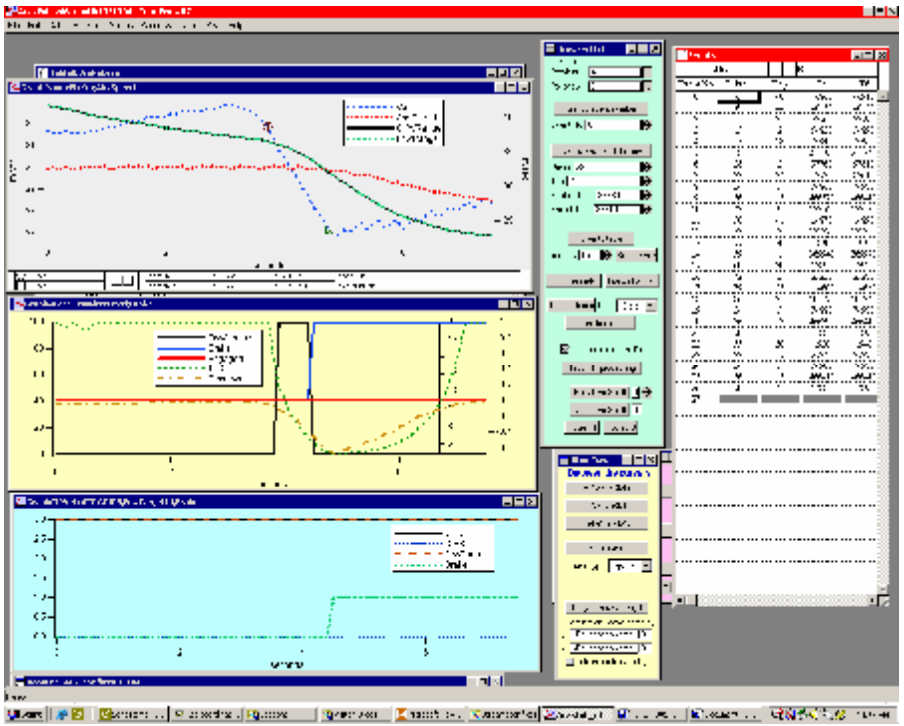
Meta-data relational database

UMTRI Tools and Techniques

- Data mining and maintenance issues
  - Less data is better than unmanageable data
  - Database development for mining is key
  - Relational databases and “core” database structures
    - Ability to make comparisons across datasets, reuse analysis routines, minimize “relearning”
  - Documentation and accessibility can be significant challenges
    - Your knowledge can’t graduate with the students

UMTRI Tools and Techniques





Customized analysis and visualization tools for meta data

UMTRI Tools and Techniques

- UMTRI has used a variety of data transfer techniques
  - Wireless remote
    - Cellular transfer of summary data
    - Remote system diagnostics
  - Wireless site based
    - WiFi-based data transfer to stations, and high-speed networking back to UMTRI
  - On-board storage
    - Cheapest and most reliable, but not always convenient

UMTRI Tools and Techniques

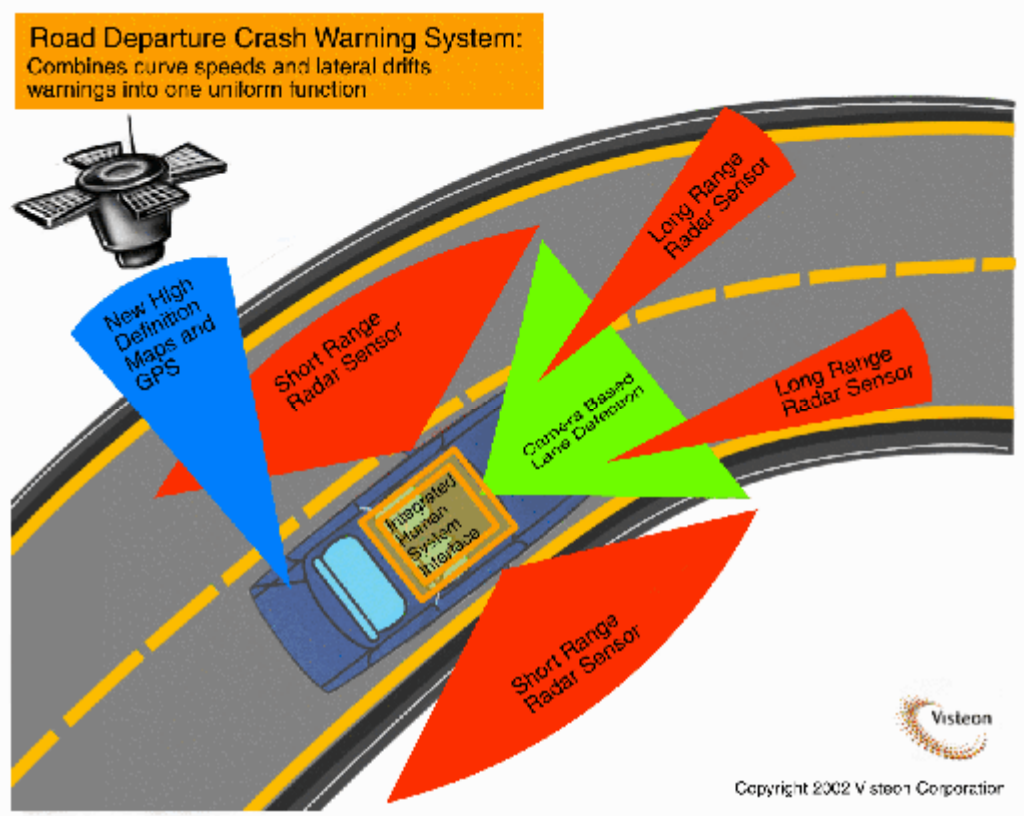
- Making the data manageable
  - Variety of image and data compression techniques
  - Buffering video images and using triggering mechanisms to save video and higher than normal frame rates
  - On-board data processing
    - You have one or two CPUs that can be processing data in parallel

Interesting Findings

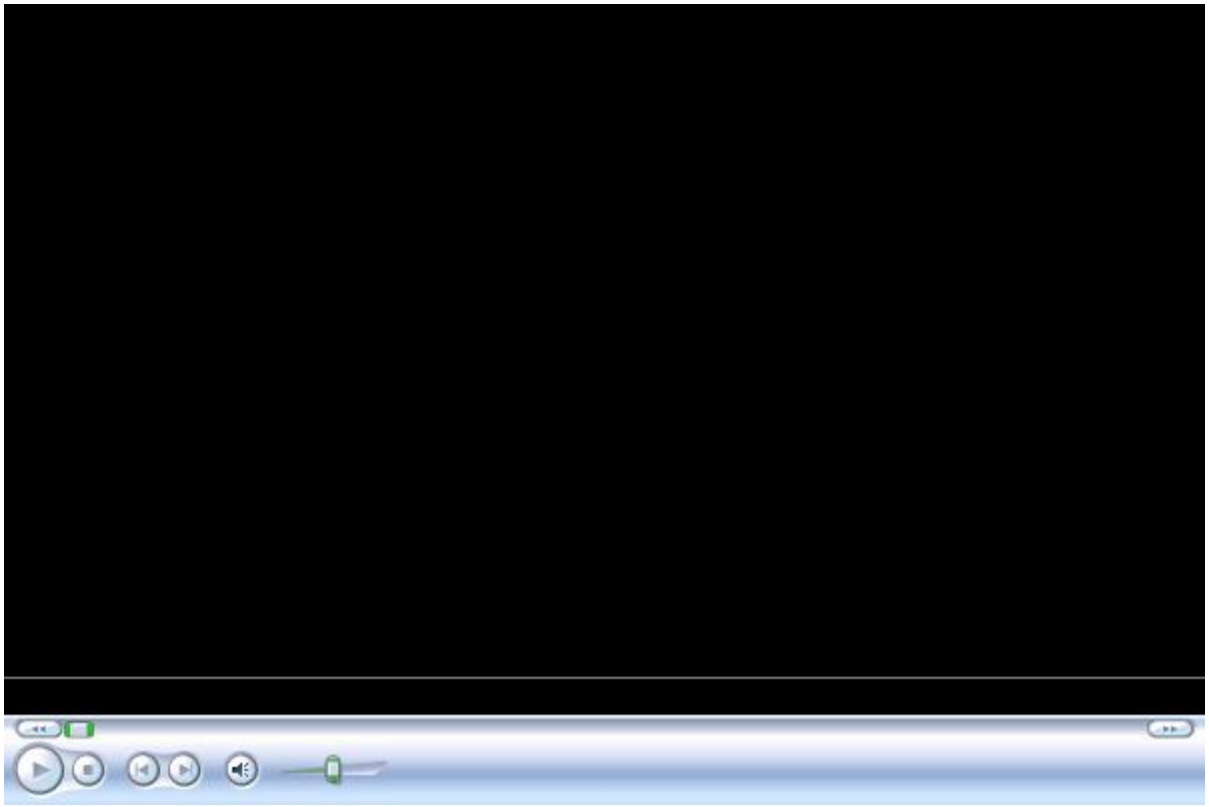
- Benefits of Lateral Drift Warning (LDW)
  - Does an LDW system improve driver safety?
- Effects of secondary behaviors on driving performance
  - How does conducting secondary tasks affect driving performance

Findings: Lateral Drift Warning

- **Enhanced Lane Departure Warning system**
  - **Prevent drivers from leaving their lane**
  - **Image processing and radar data**

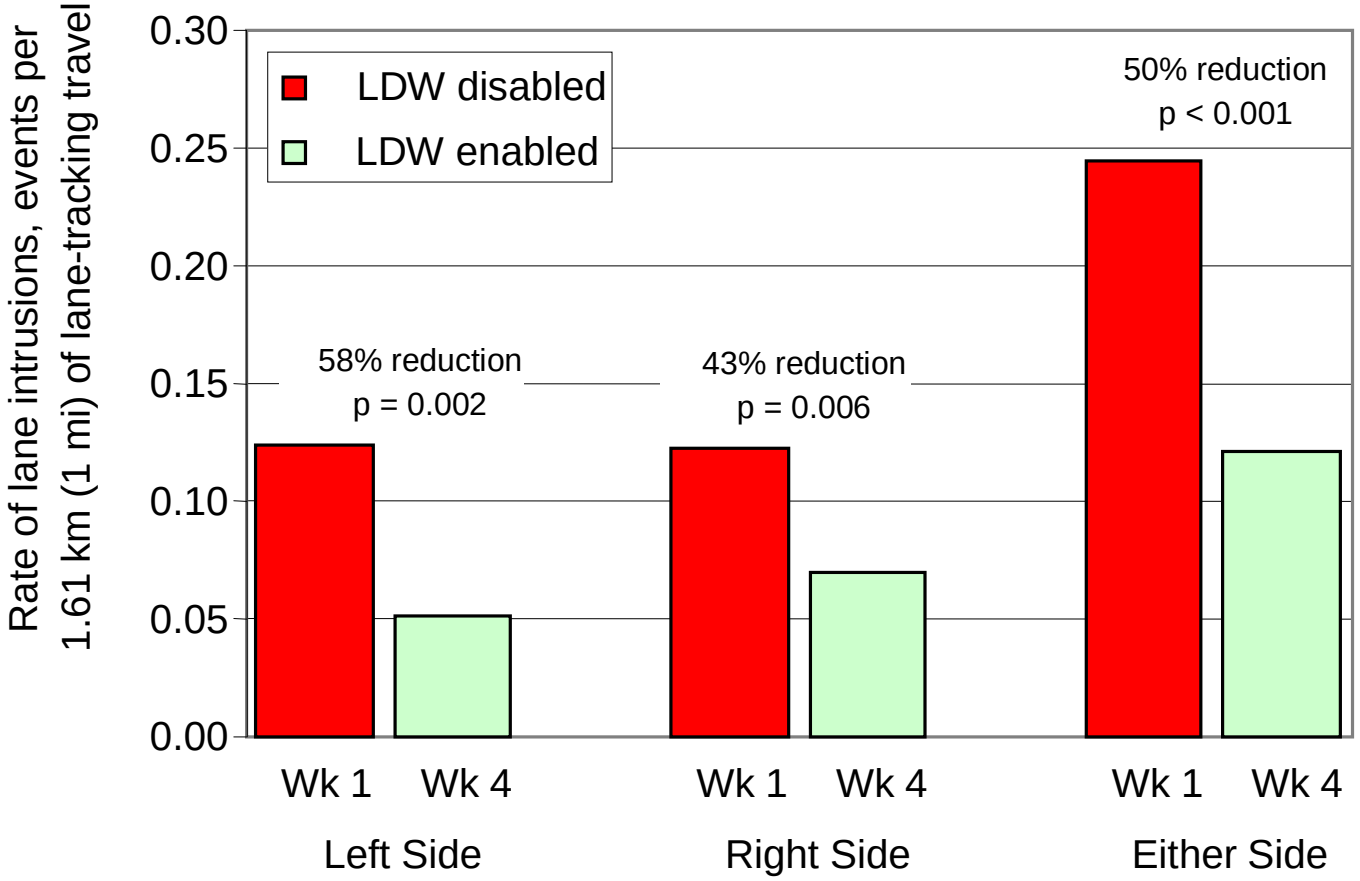


Findings: Lateral Drift Warning



Findings: Lateral Drift Warning

Rate of events in which vehicle edge comes within 0.1m of lane edge



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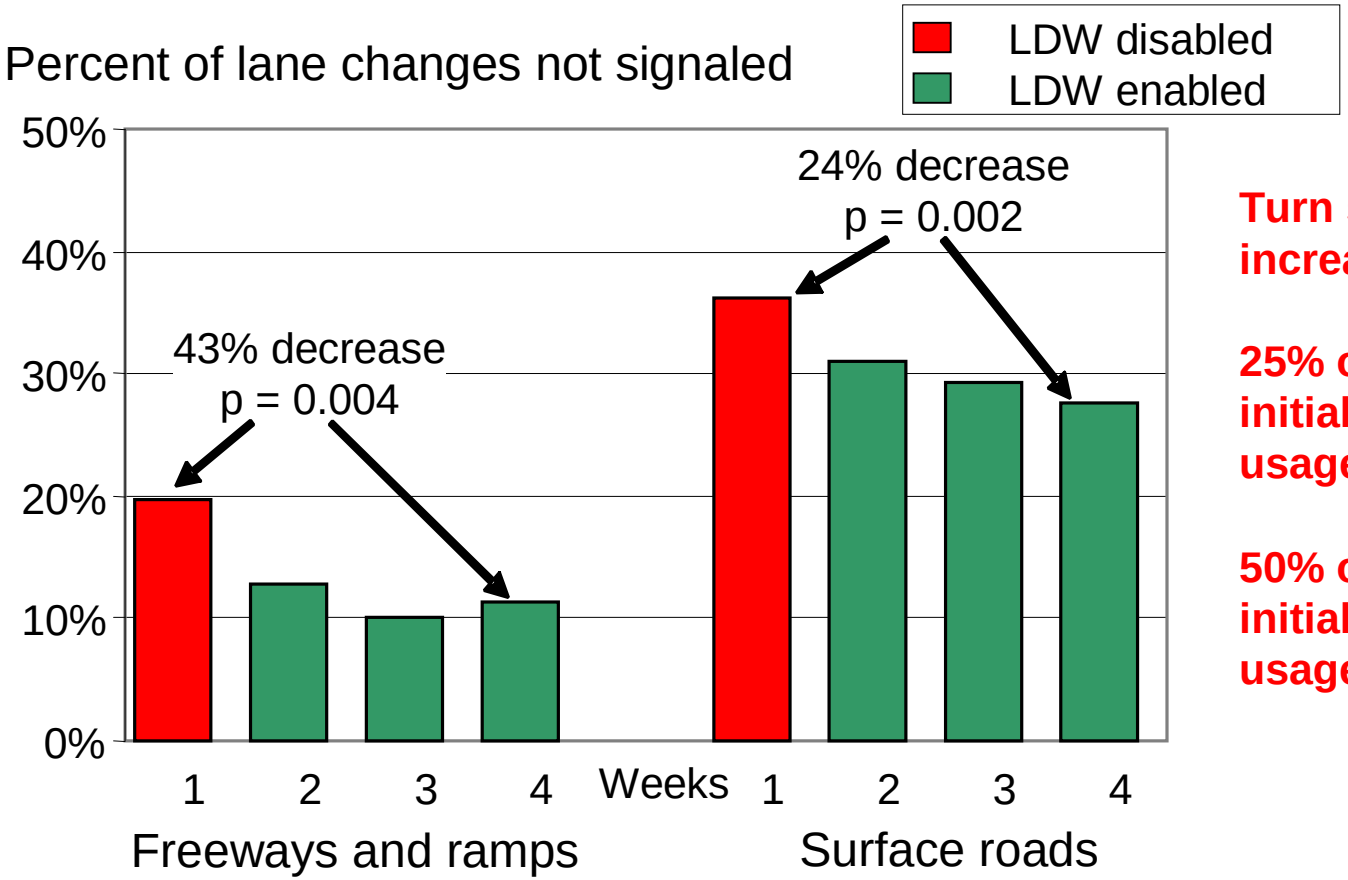


Turn signal use per mile increases 18%:

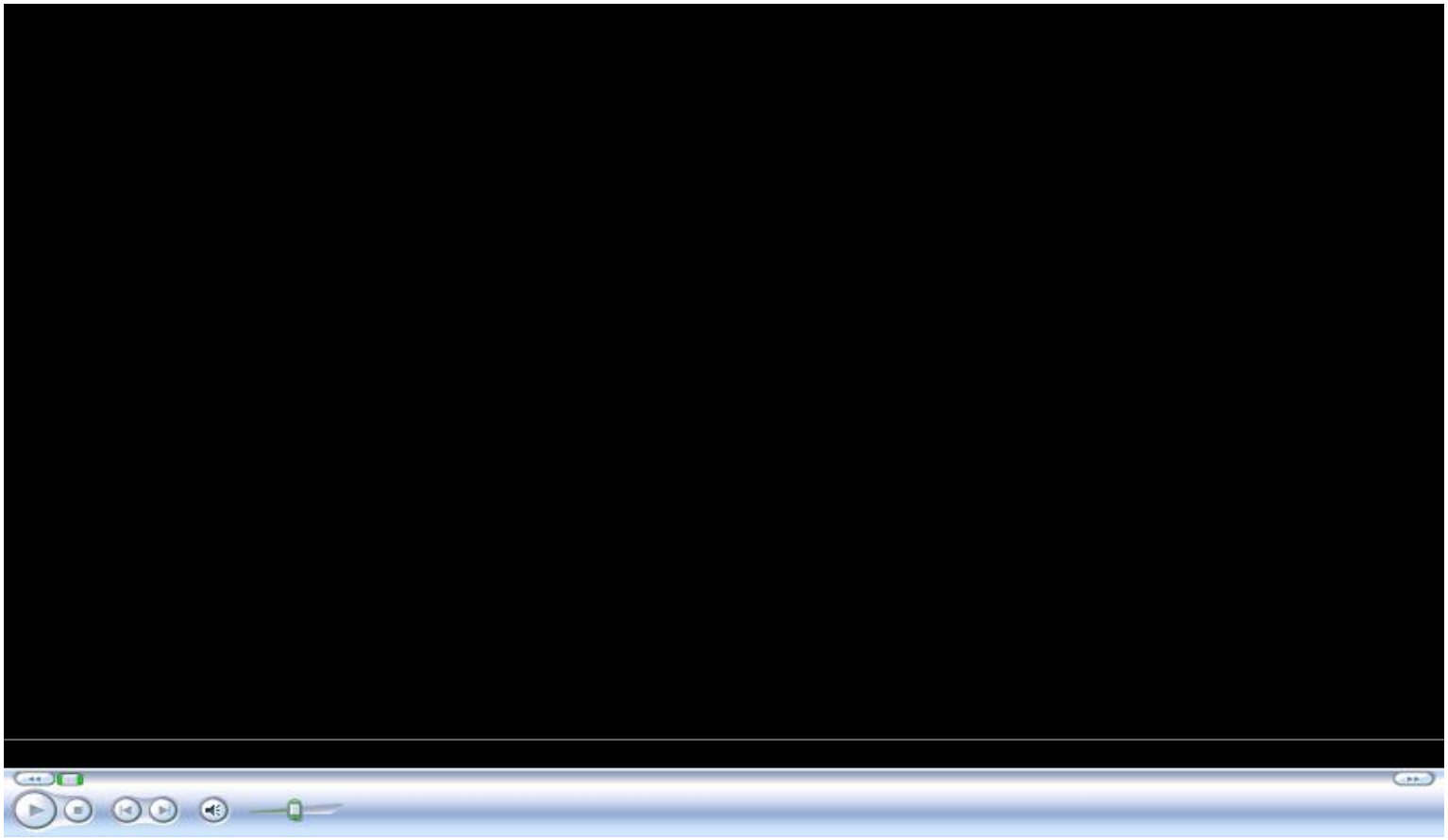
25% of drivers with lowest initial signal use increase usage 96%.

50% of drivers with lowest initial signal use increase usage 55%

Findings: Secondary Behaviors

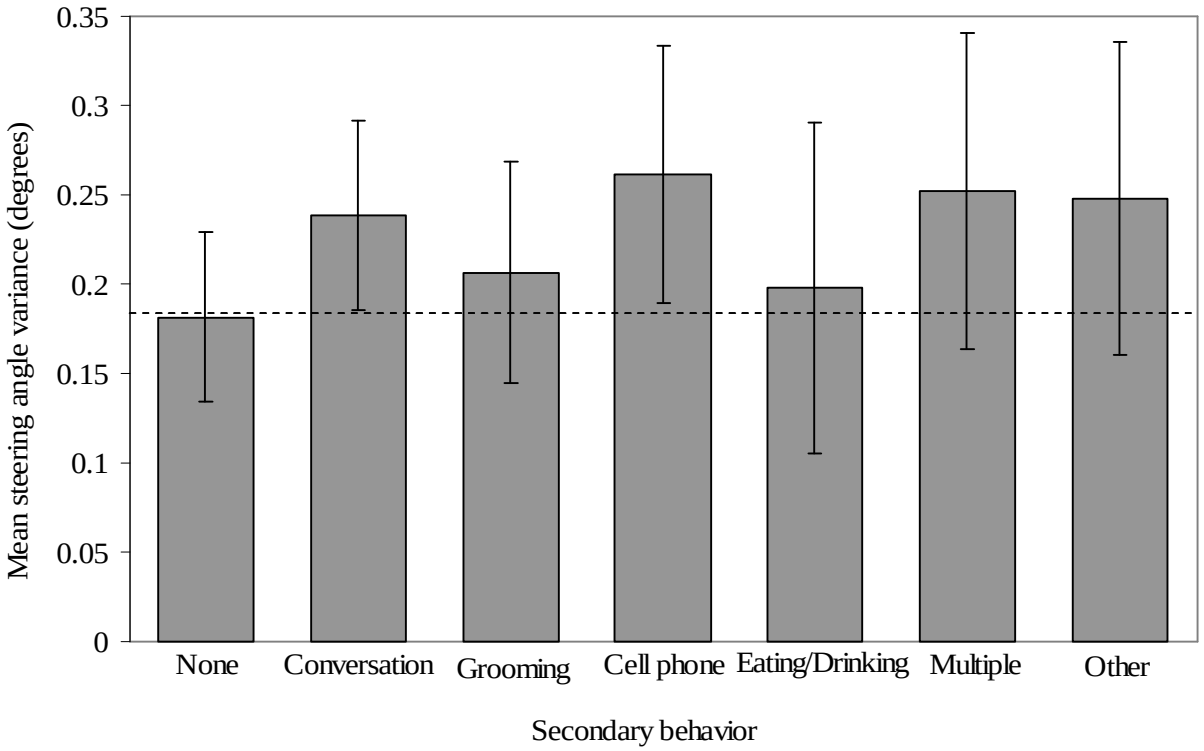
- Drivers engaged in secondary behaviors in approximately 34% of the video clips
  - Conversation with passengers (15.3%)
  - Grooming (6.5%)
  - Cellular phone (5.3%)
- Younger drivers, and women, were more likely to engage in secondary behaviors
  - Y (42%), M (37%), O (20%)
  - F (54%), M (46%)

Findings: Secondary Behaviors



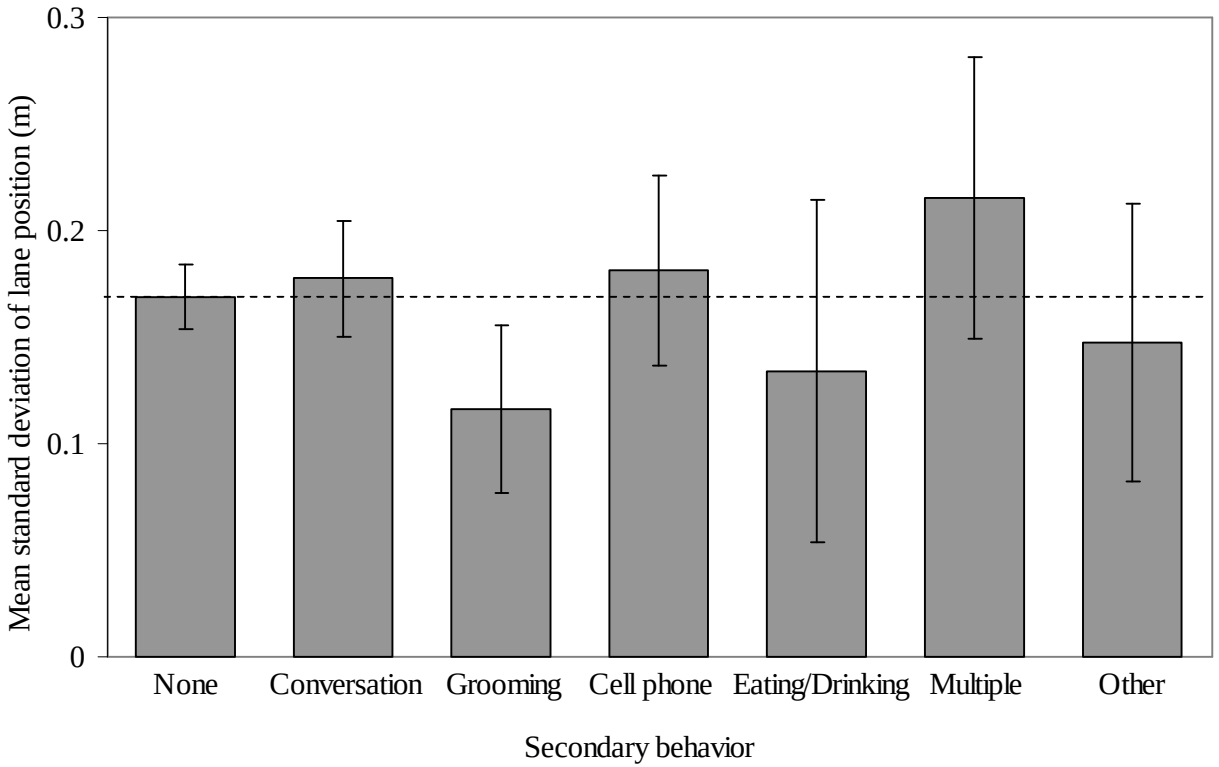
Findings: Secondary Behaviors

- Secondary tasks were associated with significantly higher variability in steering angle



Findings: Secondary Behaviors

- Secondary tasks had less affect on lane position



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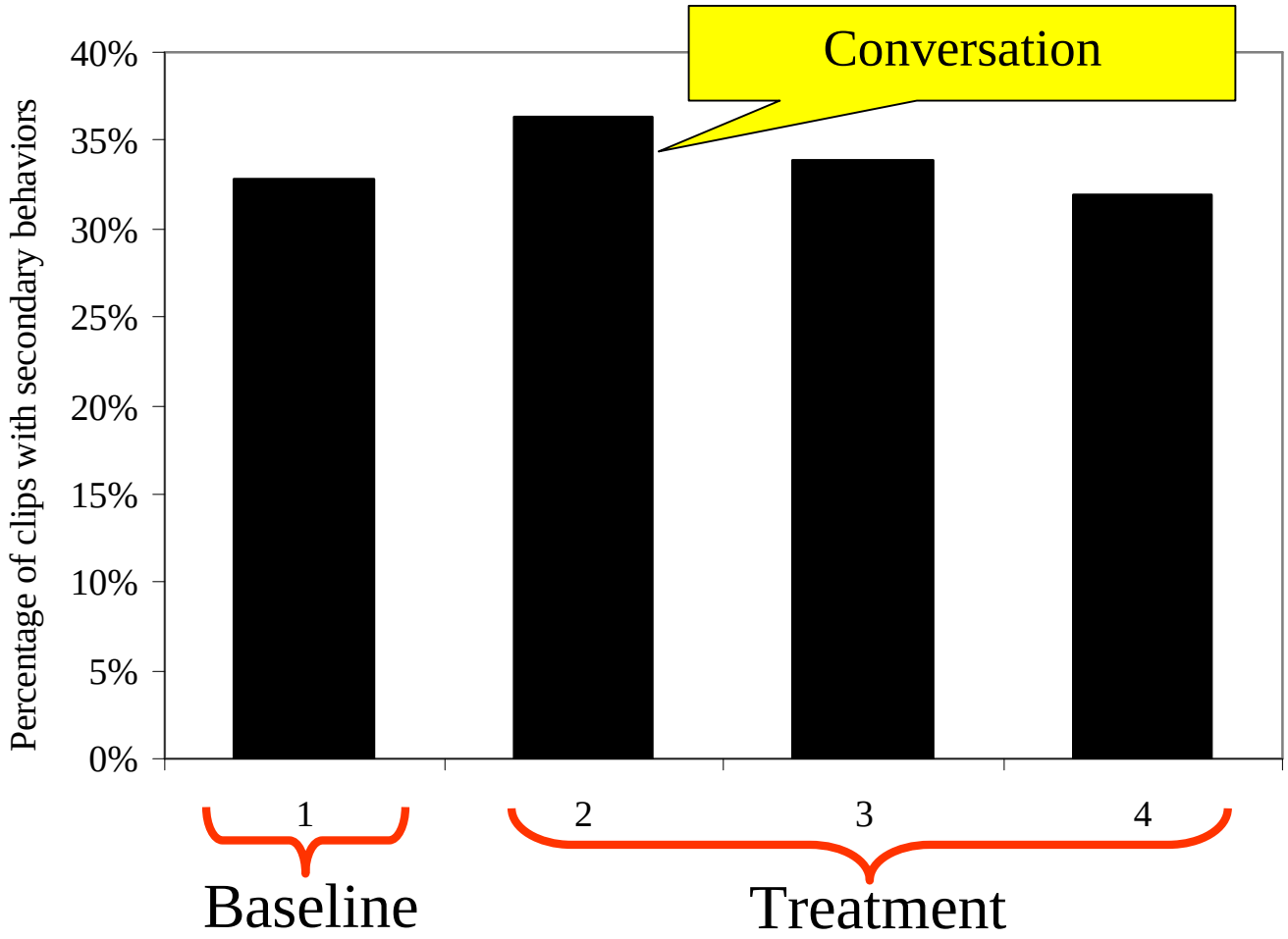

Summary

- Naturalistic driving studies can provide valuable information
  - Baseline behavior and new systems use
  - Unique data for modeling driver behavior
- Challenges include:
  - Sampling / representation
  - Data management and analysis techniques
  - Modeling new system use with naturalistic data