Naturalistic Driving Studies Fatigue Results: Prevalence while driving and contribution to crash events

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Naturalistic Driving Studies

- No experimenter present
- Participants drive as they normally would
- Collected (preferably) in privately owned vehicles
- Unobtrusive instrumentation
- Provide:
  - Detailed pre-crash information
  - Real-life behaviors
  - Rich databases for subsequent mining

Why develop a new methodology? Human performance contributes to more than 90% of crashes

- A subset of factors creates the majority of the crash risk
  - Impairment (primarily alcohol)
  - Inattention and distraction
  - Drowsiness/Fatigue
  - Judgment-related error
- Current methods of studying driver performance/behavior and their safety impacts have limitations
  - Detailed pre-crash information is not available from crash databases

Data Acquisition Systems (DASs)

- Three packaging options with differing capabilities to be selected based on project needs
  - ➢ Flex DAS
    - o High bandwidth: Up to 8 high resolution cameras
    - o Powerful processing: Multiple external sensors and networks
    - o Provides a wide array of I/O options
  - ➢ NextGen
    - o Highly configurable
    - o Quickly installed within any vehicle
    - o Large capacity data collection
    - o Distributed sensors network, including NTSC cameras for flexibility
  - ➢ MiniDAS
    - o Simple self-contained unit with integrated sensor packaging
    - o Rapidly install in any vehicle (20 minutes)
    - o High-quality, fully digital 2-channel video

NextGen DAS

MiniDAS

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The Second Strategic Highway Research Program Naturalistic Driving Study (SHRP 2 NDS)

- Largest NDS ever performed
  - 3,542 drivers; diverse age/gender groups
  - 4,368 data years; 5,512,900 trip files
  - Up to two years of data collection per participant
  - Light vehicles and SUVs
- Six data collection sites
- Integration with detailed roadway information
- Data useful for next generation of researchers
  - >1,600 crashes
  - >2,900 near-crashes (i.e., "it would have been a crash, but…")
  - 32,475,671 miles of driving
  - **~2 petabytes of data (1 PB = 1,024 TB = 1,048,576 GB)**

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Example Data Use: Estimating Prevalence and Risk of Fatigued Driving

Three types of fatigue observations that can be analyzed in naturalistic driving data

1. Overt detection through a comprehensive data reduction process
2. A more detailed analysis of behavioral symptoms using metrics like PERCLOS or Observer Ratings of Drowsiness (ORD)
3. An “process of elimination” analysis of factors that can’t be directly observed, including cognitive distraction, mind wandering, and/or microsleep episodes

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Fatigue

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Alcohol+Fatigue impaired Driving

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Crash Risk Factor and Prevalence Evaluation Using Naturalistic Driving Data

- First analysis to use 905 property damage and injury crashes collected a part of a National Academies five year study.

- Looked at observable impairment, driver performance error, driver judgment error, and observable driver distraction

- Comparison baselines include *only* alert, attentive sober driving
  - In other words “Model Driving”
  - First chance to try this; Odds ratios will be higher

- Published in *Proceedings of the National Academy of Sciences*

	O.R. (95% CI)	Baseline Prevalence
*Observable Impairment**		
Overall	5.4 (3.9 - 7.4)	1.92%
Drug/alcohol	39.1 (18.6 - 82.1)	0.08%
Drowsiness/fatigue	3.5 (2.3 - 5.3)	1.57%
Emotion (anger, other)	10.9 (5.6 - 21.2)	0.22%
Driver Performance Error		
Overall	19.6 (15.9 - 24.2)	4.81%
Major error sub-categories (observed in crash and baseline events):		
Apparent inexperience with vehicle/roadway	218.5 (118.1 - 404.2)	0.07%
Blind spot error	47.6 (17.5 - 129.5)	0.05%
Improper turn	101.2 (75.2 - 136.1)	0.51%
Right-of-way error	978.9 (128.9 - 7432.9)	0.01%
Signal violation	29.8 (16.6 - 53.5)	0.19%
Stop/yield sign violation	8.3 (5.4 - 12.7)	1.05%
Wrong side of road	24.8 (13.3 - 46.2)	0.19%
Driving too slowly	2.6 (1.2 - 5.3)	0.97%
Sudden or improper braking/stopping	214.1 (44.1 - 1039.9)	0.01%
Failed to signal	2.5 (1.5 - 4.0)	2.27%

2) A more detailed analysis of behavioral symptoms using metrics like PERCLOS or Observer Ratings of Drowsiness (ORD)

- A PERCLOS analysis using the same criteria of “model” baselines and the 905 crashes and minor collisions:
- Baseline prevalence is approximately 6% for PERCLOS 3 (80% eyelid closure for more than 12% of the time)
- For crashes, the prevalence was approximately 10% across crash-types
- The OR calculation was significant with a point estimate of 2.80

3) A “process of elimination” analysis of factors that can’t be directly observed, including cognitive distraction, mind wandering, and/or microsleep episodes

- Previous studies used:
  - Peripheral Detection Task to assess cognitive loading
  - Physiological measures associated with Electroencephalographic (EEG) activity and Event-related Brain Potentials (ERPs)
- Some methods require invasive measurement equipment operated by an experimenter in close proximity
  - Difficult to identify signal from noise
- Virtually impossible to capture through crash investigations

Using NDS to Identify Cognitive Distraction/Mind wandering/Microsleep

- Review 30 s of data surrounding each SHRP 2 NDS crash (20 s prior to the precipitating event and 10 s after) and 20 s surrounding each baseline sample to determine what contributing factors
- The number of cases where the driver was simply looking forward and either failed to react or was late in reacting was very small.
  - Ex. Hands-free cell use was associated with 2 of the 905 crashes
- If you remove tasks that have a large cognitive component but with occasional glances away (e.g., actively interacting with a passenger) or a manual component (hand-held cell conversation) the odds ratios were not significant and the point estimates were very close to 1.0.

Cognitive Distraction/Mind Wandering/Microsleep?

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Cognitive Distraction/Mind Wanrering/Microsleep?

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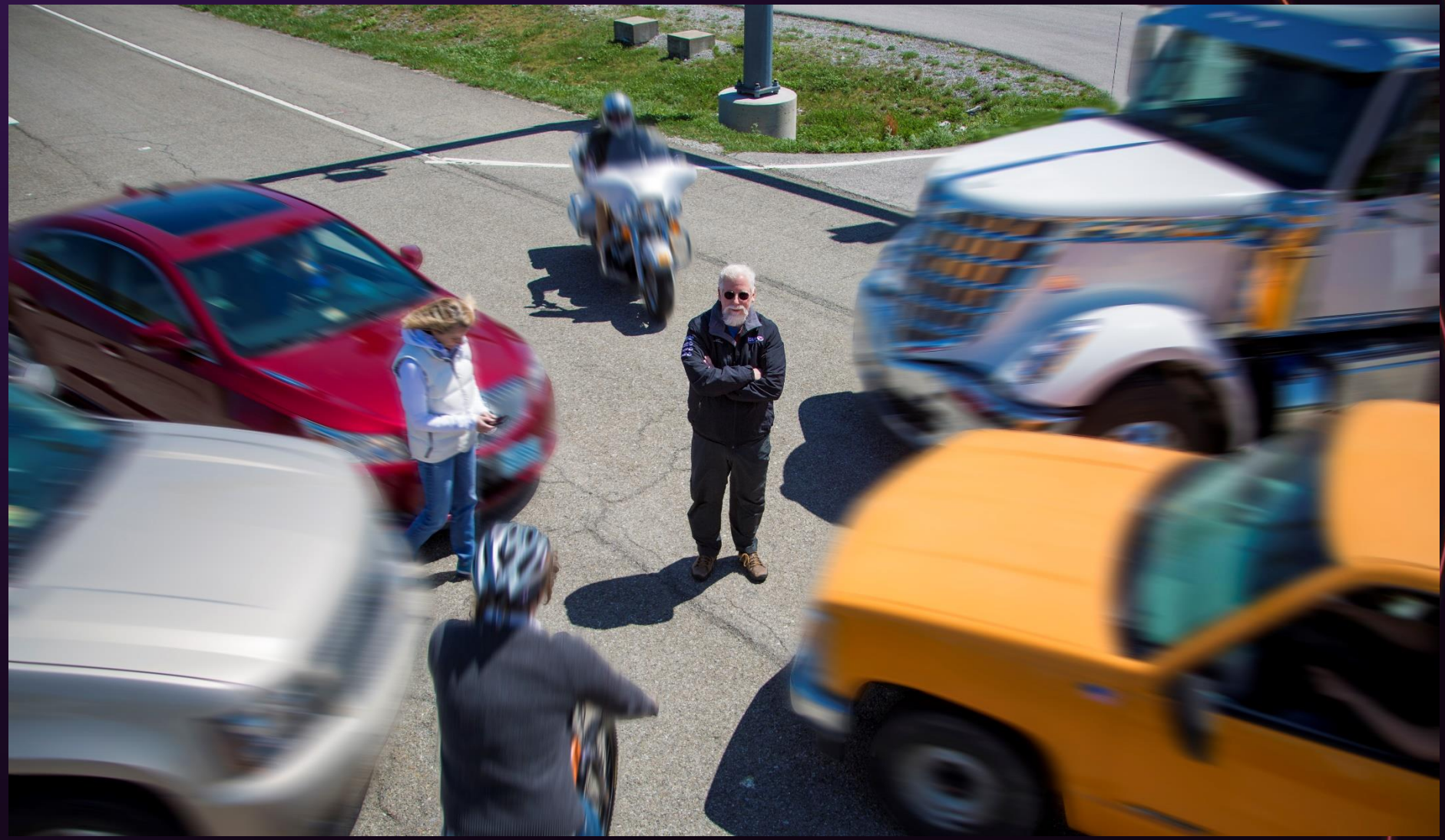
- Naturalistic driving studies conducted to date provide a wealth of information about contributing factors to crashes
- Fatigue is a substantial contributor to crashes at all times of the day, across many driver types and across many vehicle platforms
- Continuing to analyze the effects of fatigue on crashes with existing NDS data is critically important
- Continuing to grow the naturalistic database will help answer the transportation challenges of today and into the future
  - ➢ We will perpetually have 500+ vehicles on the road

Questions?



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