NEAR CRASH CHARACTERISTICS AMONG RISKY DRIVERS USING THE SHPR2 NATURALISTIC DRIVING STUDY

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BACKGROUND

• Despite advances in passive & active safety, motor vehicle fatalities continue to be a major problem
  – More than 37,000 MV fatalities in 2017 (NHTSA 2018)

• Risky drivers disproportionately represented in MVCs
  – MV Fatalities in 2016 (IIHS 2016)
    • 2,413 teen deaths
    • 4,379 young adult deaths
    • 4,792 older driver deaths
  – Teen crash rate 10x greater than experienced drivers (Seacrist et al. 2016, 2018)
  • Helps illustrate scope of problem, but…
RELEVANCE OF NEAR CRASHES

...crashes do not tell the whole story.

• Study of near crashes is needed to fully understand scope of risky driver errors
  – At-fault near crashes involve preventable error
  – May differ in type, contributing factors, or crash avoidance mechanisms

• Near crashes not reported in archival data
  – Naturalistic driving studies are a reliable method to study near crashes
PREVIOUS NATURALISTIC STUDIES

- **100-Car Study** (Dingus et al. 2006)
  - Driving behavior of 18+ yrs for one year
  - Increased near crashes among Younger vs. Older drivers

- **Simons-Morton et al. (2011)**
  - 42 teens/parents for first 18 months of licensure
  - Significantly more near crashes among teens vs. parents

- **Guo et. al (2010)**
  - Used 100-Car Study to compare crashes to near crashes
  - Increased # of factors for rear-end crashes vs. near crashes

- Studies provide useful information, however…
  - *Larger* study needed for generalization
  - Inclusive of *young* teen drivers (16-17 yrs)
STRATEGIC HIGHWAY SAFETY PROGRAM 2 (SHRP2) NATURALISTIC DRIVING STUDY

ADVANTAGES OF SHRP2 DATASET:

- Reliably capture crashes and driving exposure
  - Inclusive of all crashes and near crashes
  - Accurate number of miles driven
- Driver behavior
  - In-board cameras, secondary tasks
- Environment
  - Scene videos, crash type
- Vehicle Dynamics
  - Radar data, acceleration
OBJECTIVE

• To compute near crash rates for risky drivers and experienced adult drivers using SHRP2
  – Focus on rear-end striking events
    • Most common crash scenario for young drivers (McDonald 2014)

• Compare near crashes to crashes
METHODOLOGY
DATA SOURCE

• SHRP2 InDepth: All crashes & near crashes for:

<table>
<thead>
<tr>
<th>Group</th>
<th>Age (yrs)</th>
<th># Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teens</td>
<td>16-19</td>
<td>550</td>
</tr>
<tr>
<td>Young Adults</td>
<td>20-24</td>
<td>748</td>
</tr>
<tr>
<td>Adults</td>
<td>35-54</td>
<td>591</td>
</tr>
<tr>
<td>Older Drivers</td>
<td>70+</td>
<td>672</td>
</tr>
</tbody>
</table>

• Scene videos
• Event narratives
• Time series data
  – Acceleration, Velocity, Radar data
METHODOLOGY
DATA REDUCTION/VIDEO REVIEW

- **Near Crash** – at-fault event involving evasive maneuver to avoid a crash or departing the roadway
  - Filtered SHRP2 near crashes by incident type and fault
- **Scene videos reviewed by 2 video coders**
  - Discrepancies were reconciled by 3rd coder

**Incident Types**
- Rear-End Strikes
- Road Departures
- Intersections
- Pedestrian/Cyclist
- Side-Swipe
- Head-On
- Animal
- Other
METHODOLOGY
DATA REDUCTION/VIDEO REVIEW

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Incident Types

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- Head-On
- Animal
- Other
METRICS

• Near crash rates per million miles driven
  – Incident Type
  – Secondary Tasks
  – Evasive Maneuvers
  – Vehicle Dynamics

• Comparison of crashes & near crashes

Compared across age
RESULTS
EXEMPLARY NEAR CRASHES

- Both events involve distracted drivers (cell phone use)
NEAR CRASH RATES & EXPOSURE

<table>
<thead>
<tr>
<th>Group</th>
<th>Miles Driven</th>
<th>Near Crashes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teens</td>
<td>4,205,474</td>
<td>779</td>
</tr>
<tr>
<td>Young Adults</td>
<td>7,691,129</td>
<td>1206</td>
</tr>
<tr>
<td>Adults</td>
<td>5,651,315</td>
<td>583</td>
</tr>
<tr>
<td>Older Drivers</td>
<td>4,766,699</td>
<td>348</td>
</tr>
<tr>
<td>Total</td>
<td>22,314,617</td>
<td>2916</td>
</tr>
</tbody>
</table>

- Greater near crash rate with decreasing age
- Elevated near crash risk reflective of previous archival & naturalistic crash data

(Williams et al. 2003; Dingus et al. 2006; Guo et al. 2010; Simons-Morton et al. 2011; Seacrist et al. 2016)
NEAR CRASH RATES BY INCIDENT TYPE

<table>
<thead>
<tr>
<th>Group</th>
<th>Miles Driven</th>
<th>Rear-End</th>
<th>Road Departure</th>
<th>Intersection</th>
<th>Pedestrian/Cyclist</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teens</td>
<td>4,205,474</td>
<td>147.4*</td>
<td>12.6*</td>
<td>11.4</td>
<td>2.4*</td>
</tr>
<tr>
<td>Young Adults</td>
<td>7,691,129</td>
<td>125.5*</td>
<td>4.9</td>
<td>9.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Adults</td>
<td>5,651,315</td>
<td>72.5*</td>
<td>2.5</td>
<td>11.9</td>
<td>5.1</td>
</tr>
<tr>
<td>Older Drivers</td>
<td>4,766,699</td>
<td>42.8*</td>
<td>1.9</td>
<td>14.7</td>
<td>4.0</td>
</tr>
</tbody>
</table>

* *p<0.05

- Teens had greater Rear-End, Road Departure rates
- Intersection near crashes did not vary by group
  - Potentially a persistent problem across age
- Teens exhibited lowest pedestrian/cyclist rate
  - Possible differences in road type traveled (urban vs. rural)
PEDESTRIAN NEAR CRASHES

Teen

Adult
No major differences in secondary tasks between ages.
NEAR CRASH EVASIVE MANEUVERS

No differences in evasive maneuver type between groups

- Teen
  - Braked: 100%
  - Swerved: 0%
  - Both: 0%
  - None/Other: 0%

- Young Adult
  - Braked: 100%
  - Swerved: 0%
  - Both: 0%
  - None/Other: 0%

- Adult
  - Braked: 100%
  - Swerved: 0%
  - Both: 0%
  - None/Other: 0%

- Older Driver
  - Braked: 100%
  - Swerved: 0%
  - Both: 0%
  - None/Other: 0%
Crash avoidance mechanism *similar* among teens, young adults, adults.

\[ \text{Near Crash Severity} = \frac{\Delta V^2}{2 \cdot \Delta X} \]

*Near Crash Severity and TTC at time of braking*
WHY DO YOUNG DRIVERS ENCOUNTER MORE CRITICAL EVENTS?

Shorter Following Distance (McDonald 2013; Montgomery 2014)
Inattention/ Distraction (Curry et al. 2011)
Poor Hazard Perception (McDonald et al. 2015)

RISKIER BASELINE DRIVING

Near Crash

Similar reaction to Adults

Poor reaction to emergencies (Loeb et al. 2015)

Crash

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CRASHES VS. NEAR CRASHES
SECONDARY TASKS & EVASIVE MANEUVERS

Secondary Tasks

- Similar Presence of Secondary Tasks (p = 0.92)
- 68% Crash, 66% Near Crash

Evasive Maneuvers

- More Evasive Maneuvers (*p < 0.01)
- 99% Near Crash, ?% Crash, 68% Crash, 68% Near Crash
CRASHES VS. NEAR CRASHES
TIME-TO-COLLISION AT BRAKING

- Drivers respond later during rear-end crashes
- Other potential factors
  - Environmental (weather, time of day, road type)
  - Driver (sociodemographic, behavioral, experience)

Shorter Time-to-Collision
(*p < 0.05)

Time-to-Collision (sec)

- Crash
- Near-Crash

0
1
2
3
4

2.2
3.1

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LIMITATIONS & FUTURE WORK

• Vehicle Dynamics analysis focused on rear-ends
• Radar data available for ~55% of rear-end near crashes
  – Subset may not be representative of all events
• Included *at-fault* events only
• Did not account for driver, environment variables
  – In-depth analysis an area of future work
CONCLUSIONS

• Provides comparison of near crashes among risky drivers using large naturalistic dataset
  – Frequency, type, tasks, evasive maneuvers
  – Comparison to crashes

1) Tailor driver training to target common errors
2) Inform driver-specific ADAS

**Teen** – emphasize rear-end, road departure
**Adult** – pedestrian zone interventions
**All Groups** – intersection persistent problem
ACKNOWLEDGEMENTS

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- VTTI Staff for assistance with SHRP2 data/DUL
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