100-Car Naturalistic Driving Study

Setting up the Study

Study Sponsors
- National Highway Traffic Safety Administration (NHTSA)
- Virginia Department of Transportation (VDOT)
- Virginia Transportation Research Council (VTRC)
- Virginia Tech (VT)

Study Parameters
- 109 primary drivers, 241 total drivers
- Northern Virginia/Metropolitan Washington, DC area
- 12 – 13 months of data collection
- Drivers’ ages ranging from 18 to 73; 60% male; 40% female

100-Car Study Features
- First large-scale instrumented-vehicle study undertaken with the primary purpose of collecting pre-crash and near-crash naturalistic driving data.
- Captured a range of crash severities: airbag deployments to minor, low-force, no-property-damage crashes.
- First study to collect detailed information on a large number of near-crash events.
- Drivers were given no special instructions and no experimenter.
- Instrumentation was unobtrusive.

Data Collection Instrumentation Included
- Five channels of digital video
- Front and rear radar sensors
- Accelerometers
- Machine vision-based lane tracker
- GPS
- Vehicle speed sensor

The Database
- Contains many extreme driving cases, including severe drowsiness, impairment, judgment error, risk taking, secondary task engagement, aggressive driving and traffic violations
- Each safety-related conflict was classified as one of the following:
  - Crash – any physical contact between the subject vehicle and another vehicle, fixed object, pedestrian, pedalcyclist or animal.
  - Near-Crash – situations requiring a rapid, severe evasive maneuver to avoid a crash.
  - Incident – situations requiring an evasive maneuver occurring at less magnitude than a near-crash.

Top Level Database Statistics
- Approximately 2,000,000 vehicle miles
- 42,300 hours of driving data
- 15 police-reported and 67 non-police-reported crashes
- 761 near-crashes
- 8,295 incidents

Types of Driving Behavior Recorded
- Drowsiness
- Driver inattention
- Traffic violations
- Aggressive driving and "road rage"
- Seat belt usage

Discoveries

Driver Inattention
- Nearly 80% of all crashes and 65% of all near-crashes involved driver inattention just prior to (i.e., within 3 seconds) the onset of the conflict.

Rear-End-Striking Crashes
- Visual inattention was a contributing factor for 93% of rear-end-striking crashes.
- In 86% of rear-end-striking crashes, the headway at the onset of the event was greater than 2.0 s.
Most near-crashes involving conflict with a lead vehicle occurred while the lead vehicle was moving, while 100% of the crashes (14 total) occurred when the lead vehicle was stopped. This indicates that drivers are aware and able to perform evasive maneuvers when closing rates are lower and/or expectancies are not violated.

Five channels of digital video collected real-world data that lends itself to multiple additional analyses.
Age-Related

- Judgment error, including secondary task performance in higher risk situations, driving while impaired, and other instances of aggressive driving, was much more prevalent in the youngest age group (i.e., 18 to 20 years) relative to the older age groups.
- The rate of inattention-related crash and near-crash events decreased dramatically with age, with the rate being as much as four times higher for the 18- to 20-year-old age group relative to the older groups (i.e., 35+ years).

Hand-Held Wireless Devices

- Primarily cellphones, but included a small amount of PDA use.
- Associated with the highest frequency of distraction-related events for both incidents and near-crashes.

Driver Drowsiness

- Contributing factor in 20% of all crashes and 16% of all near-crashes, while most current database estimates place fatigue-related crashes at a much lower percent (i.e., under 10%) of total crashes.

Inattention Analysis Purpose

- To conduct an in-depth analysis of driver inattention using the driving data collected in the 100-Car Study.
- To establish direct relationships between driving inattention and crash/near-crash involvement.

Two Calculations

Relative crash/near-crash risk: defined as the increased risk for an individual driver to be involved in a crash or near-crash.

Population Attributable Risk (PAR) Percentage: defined as an estimate of the percentage of crashes and near-crashes occurring in the general population that are occurring due to increased crash/near-crash risk associated with specific factors.

Method

Driver Inattention

- Defined as one of the following:
  - Driver engagement in secondary tasks (e.g., eating, talking on a cell phone)
  - Moderate to severe driver drowsiness
  - Driving-related inattention to the forward roadway (e.g., glance to rear-view mirror)
  - Non-specific eyeglance away from the forward roadway (e.g., inopportune glance away from forward roadway)

Discoveries

Risks

- Relative Risk Findings:
  - Driving drowsy increases an individual’s near-crash or crash risk by 4 to 6 times.
  - Engaging in secondary tasks that require multiple steps or eyeglances away from the forward roadway increases risk by 2 to 3 times.
  - Certain behaviors increased the risk of involvement in a near-crash or crash. Reaching for moving objects increased risk 9 times, looking at an external object 3.7 times, reading 3.4 times, applying makeup 3 times, and dialing a hand-held device 2.8 times. Talking or listening to a hand-held device increased risk by 1.3 times, but this result was not statistically different than normal driving.
  - Looking away from the forward roadway for long glances at inopportune moments increases crash risk by 2 times.

Population Attributable Risk Percentage Findings:

- Driving while drowsy was a contributing factor for 22 to 24% of the crashes and near-crashes.
- Secondary-task distraction contributed to over 22% of all crashes and near-crashes.
- Some inattention-related activities had high risk increases but low PAR percentages because of their infrequent occurrence (i.e., reading).
- On the other hand, other activities had high PAR percentages but lower individual risk increases because of their frequent occurrence (i.e., talking on a cellphone).
- Findings suggest a clear relationship between involvement in inattention-related crashes and near-crashes and engaging in inattention-related activities during normal driving. Those who frequently chose to engage in inattention-related activities in general are more often involved in inattention-related near-crashes and crashes.