Using Naturalistic Driving Data to Examine Age and Gender Differences on Seat Belt Use

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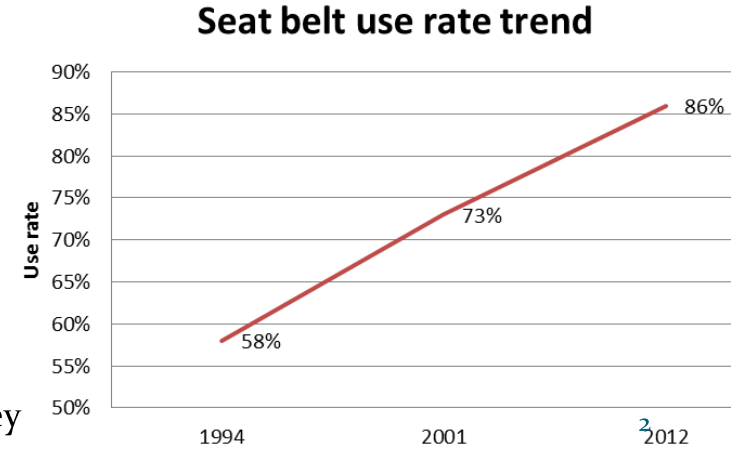
Background

- Seat-belt usage is a proven safety measure for preventing injuries and fatalities among motor vehicle drivers and passengers:
  - Nearly 48% of the 21,000 road fatality victims in the U.S. were unrestrained by seat belts at the time of the accident (NHTSA, 2012).
  - It has been estimated that front seatbelt use reduces the fatal injury risk for occupants by 45 %, and the moderate to-critical injury risk by 50% (NHTSA, 2012).
- The seat-belt use rate in the U.S. has been steadily grown over the past few decades.



NHTSA, National Occupant Protection Use Survey

Research Gap

- Studies have identified both individual and environmental factors that affect seatbelt use:
  - Young driver group had significantly lower seatbelt use rates than other age groups (Eby, Molnar, & Olk, 2000; Womack, Trout, & Davies, 1997).
  - Male drivers were less likely to wear seat belts than female drivers.
  - Different seatbelt use rates have also been observed under various travel conditions, such as time of day (Miller, Spiner, & Lestina, 1998).

- Most of the previous studies on seatbelt use based on information mainly from self-report or crash data. Self-report data usually overestimates actual use, while crash data permits no inference on general behavior and intention of the drivers.

Research Gap

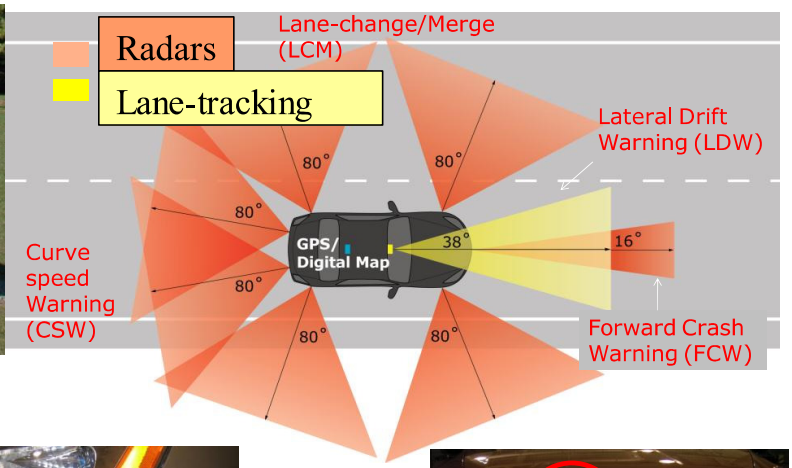
- Naturalistic driving studies have provided a unique opportunity to collect objective data to study drivers' seat belt use behavior at the individual level and trip level
  - One recent study has used naturalistic driving data to evaluate factors that associated with part-time and full-time seat belt users (Reagan, McClafferty, Berlin, & Hankey, 2013). However, no studies has examined teen drivers' on seat belt use while driving on the real roads.

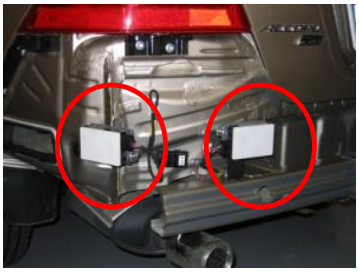
Datasets: IVBSS and Teen IVBSS

- 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)
- Teen-IVBSS program
  - Same research vehicles and safety system as in the IVBSS program
  - 40 teen drivers (16 years old with Michigan Level 2 Intermediate driving license) for a 14-week period
    - equal number of male and female drivers
    - 20 baseline group: no warning present to them at all
    - 20 treatment group drivers: 3 weeks of baseline, 8 weeks of treatment and 3 weeks of post treatment period

IVBSS Instrumented Vehicles

- 16 vehicles each with an four prototype crash warning systems
- 7 radars, 5 video streams, GPS, >500 other signals at 10 to 50 Hz

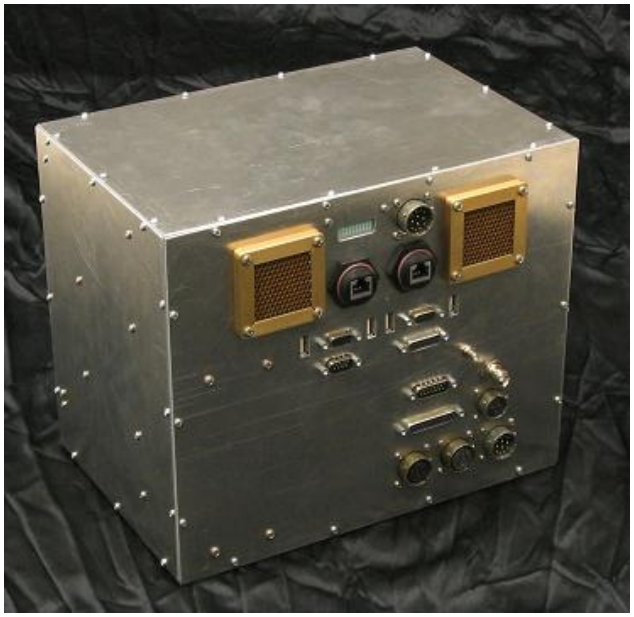




Radars behind fascias

Data Viewer Tool – Highly Reconfigurable

IVBSS Data Acquisition System



Data sources:

- CAN buses – IVBSS, OEM
- 5 cameras with video capture & compression
- 6 or 7 radars
- Onboard map match
- Two CPU system
- Automotive-grade hard disks
- Second GPS
- Vehicle motion IMU
- Microphone.....ETC!
- GPRS/Edge cellular modem
- DAS power management system

Data Analysis

- Mixed model
  - Between-subject variables: age (teen, younger, middle-aged or older) and gender (male or female)
  - Within-subject variables
    - Time of a day (day or night)
    - Wiper state (on or off), as a surrogate measure of weather condition
    - Average driving speed during each trip (continuous variable)
    - Trip distance (continuous variable)
  - Dependent variables
    - Seatbelt use was determined via a signal from the vehicles Car Area Network (CAN) bus (Yes or No).
    - The second dependent variable is when drivers buckled their seatbelts during a trip:
      - Early-stage (i.e., put on their seatbelts within 5 s of trip start)
      - Late-stage (i.e., after 5 s)

Descriptive Data Analysis

- The combined data set collected represents 313,500 miles, 37,695 valid trips, and about 9,500 hours of driving
  - Of the total 1,284 unbelted trips, teen drivers accounted for about 10.8%, younger drivers accounted for about 59.7%, middle-aged for about 16.9%, and older drivers for 12.5%
  - Male drivers accounted for 72.8% of the unbelted cases

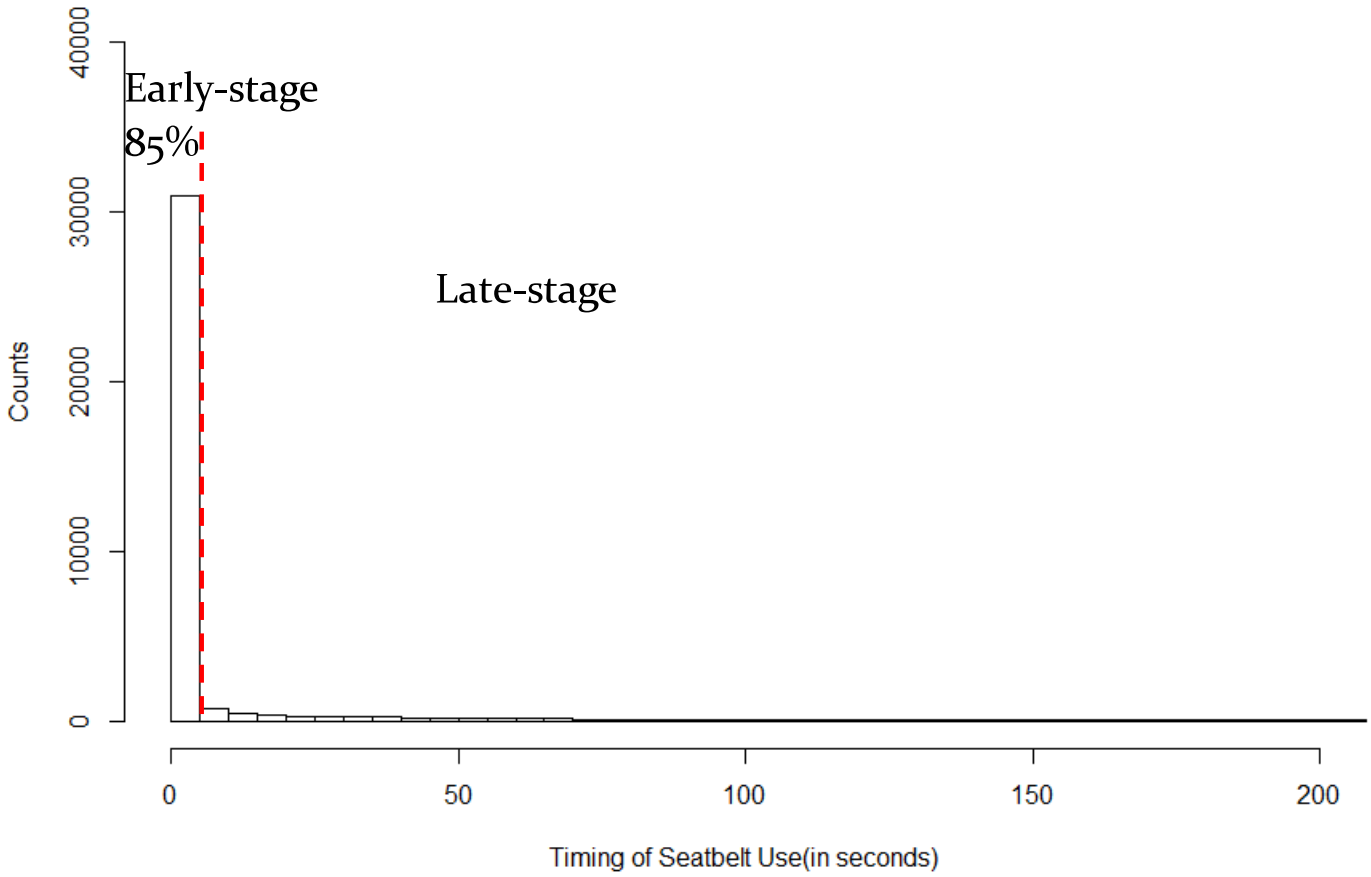
Results: Likelihood of seat belt use

- Logistic regression model

TABLE 1. Likelihood of wearing seatbelt (only significant variables were listed)

Variable		Odds Ratio (95% CI)	p-value
Age group	Teen vs. Younger	7.84 (3.31, 19.64)	<0.01.
	Teen vs. Middle	3.72 (1.62, 8.51)	<0.05
	Teen vs. Older	2.58 (1.19, 5.58)	<0.05
	Middle vs. Young	1.44 (0.73, 2.82)	n.s.
	Older vs. Young	3.03 (1.51, 6.06)	0.05
	Older vs. Middle	2.11 (0.99, 4.48)	<0.01
Gender group	Female vs. Male	2.38 (1.44, 3.91)	<0.01

When they buckled their seatbelt?



Results: Likelihood of Seat Belt Use at Early Stage

- Logistic regression model (only belted trips were used)

TABLE 2. Likelihood of seatbelt wearing at the beginning a trip (within 5 seconds)

Variable		Odds Ratio (95% CI)	p-value
Age group	Young vs. Teen	0.49 (0.34, 0.72)	<0.05
	Middle vs. Teen	0.45 (0.31,0.64)	<0.01
	Older vs. Teen	0.59 (0.37, 0.94)	<0.05
	Young vs. Middle	1.09 (0.76, 1.57)	n.s.
	Young vs. Older	0.84 (0.51, 1.35)	n.s.
	Middle vs. Older	0.76 (0.48, 1.21)	n.s.
Gender group	Male vs. Female	0.71 (0.52,0.95)	<0.05
Wiper state	On vs. Off	1.94 (1.70, 2.19)	<0.01

Conclusions

- Significant differences on the likelihood of seatbelt use between teen drivers and each of the three other age groups, with teen drivers being the most likely to use a seatbelt , followed by older, middle-aged and young drivers.
- It was also found that teen drivers were more likely to fasten their seatbelts at the beginning of a trip when compared to the other three adult groups.
- Female drivers used seatbelts more frequently and more likely to buckle seatbelts at early stage of the trip than male drivers, suggesting female drivers are generally more conservative belt users.
- Even during a belted trip, it can take quite a long time for a driver to buckle up:
  - 7% of belted trips, drivers did not buckle up for over 1 minute;
  - 1% of belted trips, drivers did not buckle up for over 8 minutes.

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Questions?

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