AUTOMATED TECHNOLOGIES: PERSPECTIVES ON PROTECTION FOR CHILDREN AND TEENS

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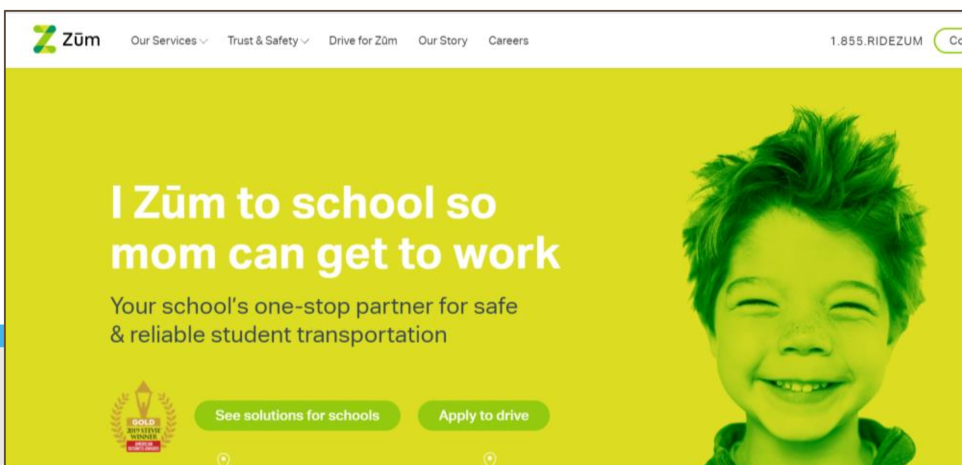
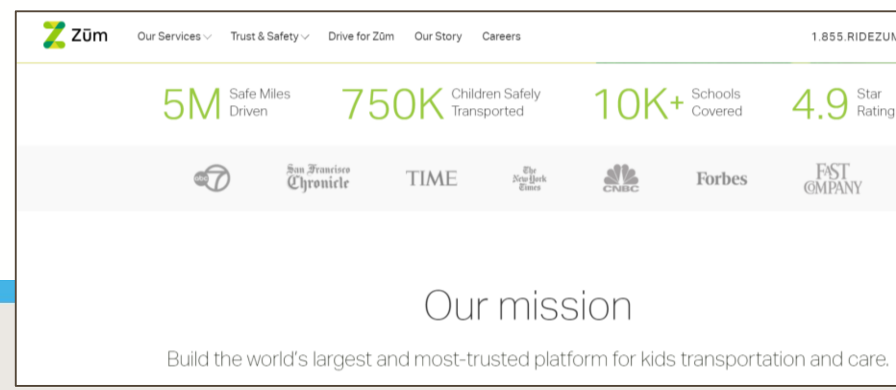
AUTOMATED VEHICLE TECHNOLOGY

- Most research focused on crash avoidance
  - Are there particular crash scenarios where technologies such as AEB are most effective?
- What about "Are there particular drivers for whom these technologies are most effective?"
- Children and youth in automated vehicles
  - Coming to a city near you…





MENU OF RESEARCH STUDIES

- Crash and near-crash scenarios vary by driver age – teens are unique
- Novel method for evaluating effectiveness of AEB for different age groups
- Thinking beyond AEB, what do families want with regard to automation?

NEED FOCUS ON TEEN DRIVERS

- *Risky teen drivers* over represented in MVCs
  - MV Fatalities in 2016 (IIHS 2016)
    - **2,413** teen deaths (age 16-19)
  - Teen crash rate **10x** greater than experienced drivers (Seacrist et al. 2016, 2018)
    - Helps illustrate scope of problem, *but*…

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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

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)

Work led by Thomas Seacrist
To be published in J. Safety Research

METHODOLOGY
DATA SOURCE

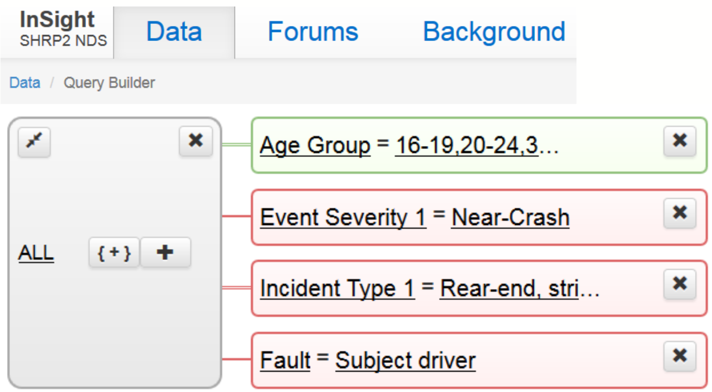
- SHRP2 InDepth:

Group	Age (yrs)	# Drivers
Teens	16-19	550
Young Adults	20-24	748
Adults	35-54	591
Older Drivers	70+	672

- Scene videos
- Event narratives
- Time series data
  - Acceleration, Velocity, Radar data

SHRP2 Raw Video Data

METHODOLOGY
DATA REDUCTION/VIDEO REVIEW



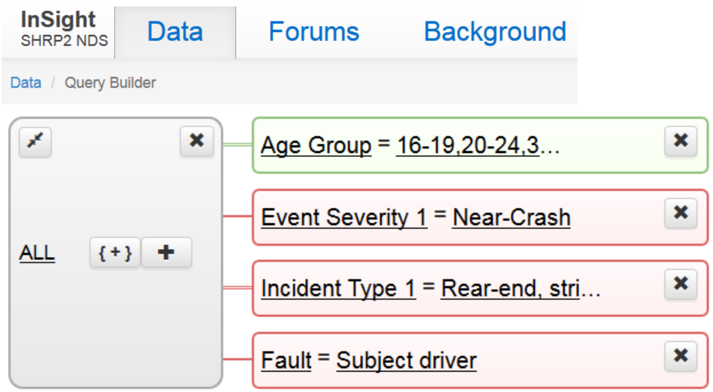
Incident Types

- Rear-End Strikes
- Road Departures
- Intersections
- Pedestrian/Cyclist
- Side-Swipe
- Head-On
- Animal
- Other

- **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

METHODOLOGY

DATA REDUCTION/VIDEO REVIEW



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RESULTS
EXEMPLAR NEAR CRASHES

- **Teen**

- **Adult**

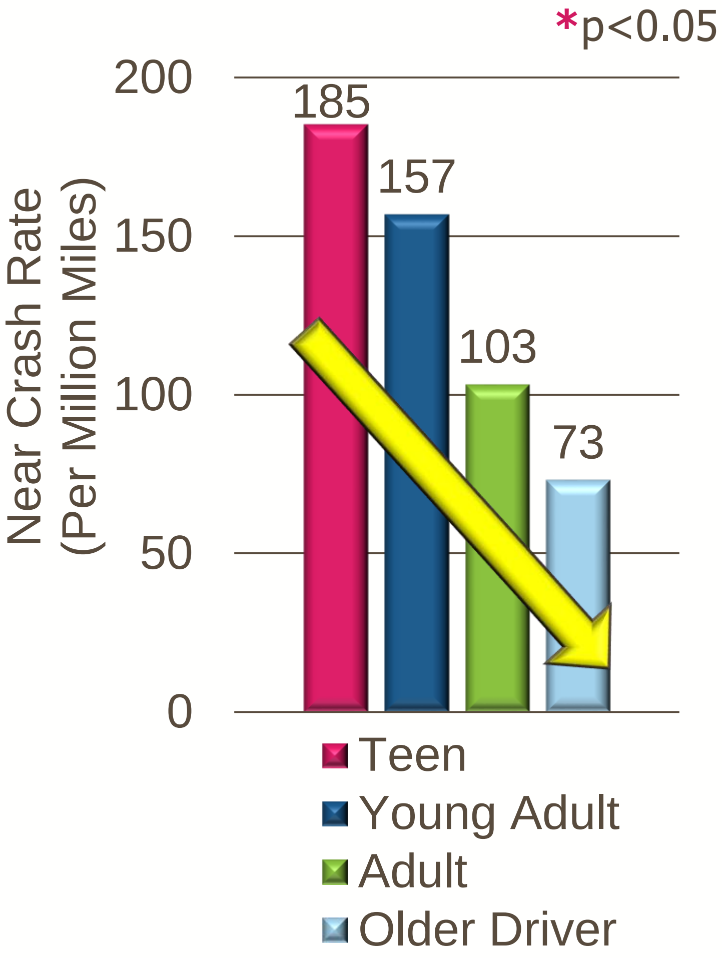
- Both events involve distracted drivers (cell phone use)

NEAR CRASH RATES & EXPOSURE

Group	Miles Driven	Near Crashes
Teens	4,205,474	779
Young Adults	7,691,129	1206
Adults	5,651,315	583
Older Drivers	4,766,699	348
Total	22,314,617	2916

- Decreased near crash rate with increasing 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)



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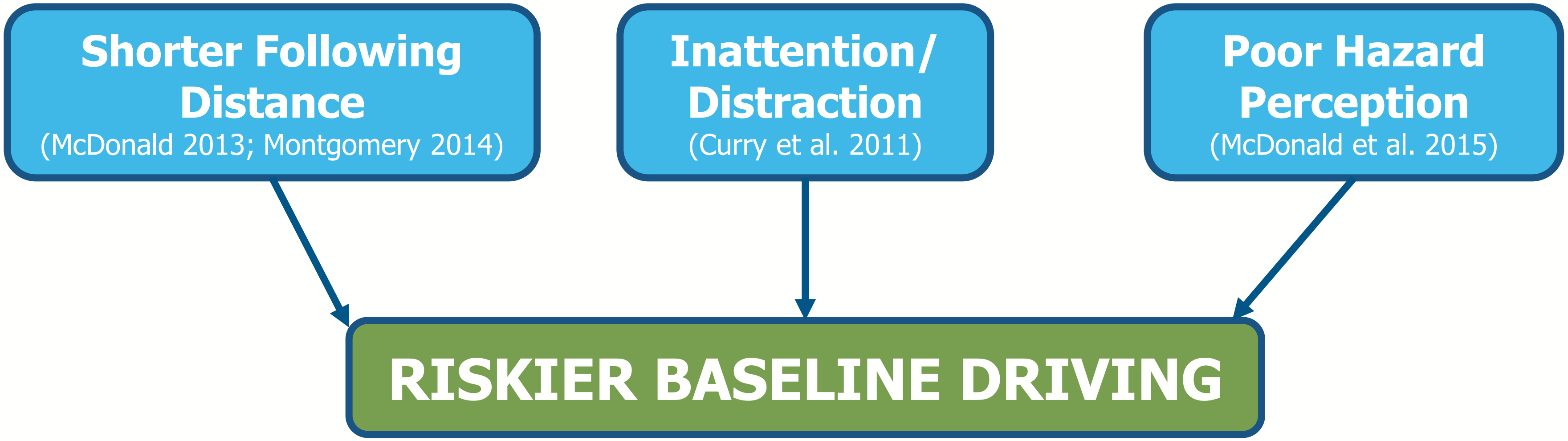
NEAR CRASH RATES BY INCIDENT TYPE

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

*p<0.05

- Teens had greater Rear-End, Road Departure rates
- Intersection near crashes did not vary by age group
- Teens exhibited lowest pedestrian/cyclist rate
  - Possible differences in road type traveled (urban vs. rural)
- Unique targeted opportunities for crash avoidance technology

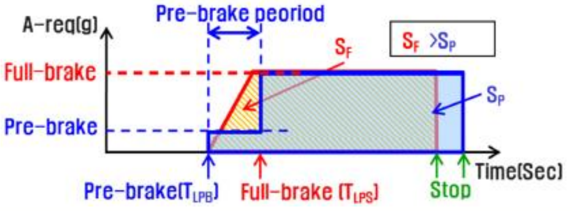
WHY DO YOUNG DRIVERS ENCOUNTER *MORE* CRITICAL EVENTS?



AUTOMATIC EMERGENCY BRAKING

- Rear-end crashes the most common crash and near-crash scenario for teens
- AEB has potential mitigate these crashes
  - Studies suggest that ADAS can prevent up to 57% of crashes and injuries
    (Kusano et al. 2010; Rosen et al. 2010; Searson et al. 2014; Kusano et al. 2014; Edwards et al. 2014, 2015)
- Limit
  - Ba
  - Use step pulse, assume constant jerk
  - Do *not* account for driver reaction or road conditions

Naturalistic Driving Studies can provide "real-world" data for AEB simulations.



METHODOLOGY
OVERVIEW

- Reviewed SHRP2 for *rear-end crashes* with reliable vehicle/radar data
  - Vehicle velocity, acceleration
  - Lead vehicle relative velocity, position
  - Environmental conditions

Real-world data prior to crash

- Conducted counterfactual AEB simulations
  - Used *"real world"* AEB deceleration profile and TTC activation times from IIHS AEB tests (IIHS TechData)
  - Accounted for *driver reaction* and *road conditions*

ACCOUNTING FOR ROAD CONDITIONS AND DRIVER REACTION

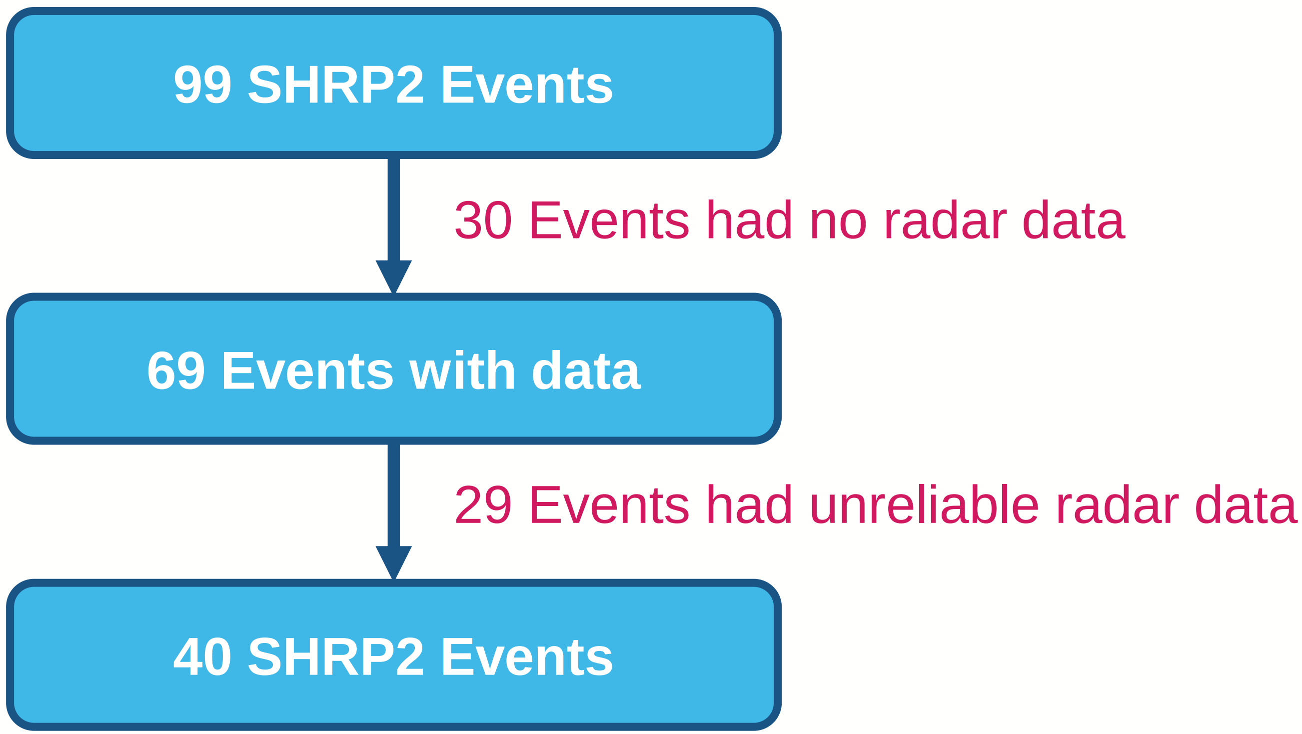
- Road conditions are known in SHRP2 crashes
- Scaled deceleration profile by road surface factor
  - Gustafsson et al. (1997) *Automatica*

Road Surface	Factor
Dry	1.0
Wet	0.7
Snowy	0.3
Icy	0.1

- If driver was already braking at time of AEB activation…
  - Started AEB deceleration curve at current deceleration

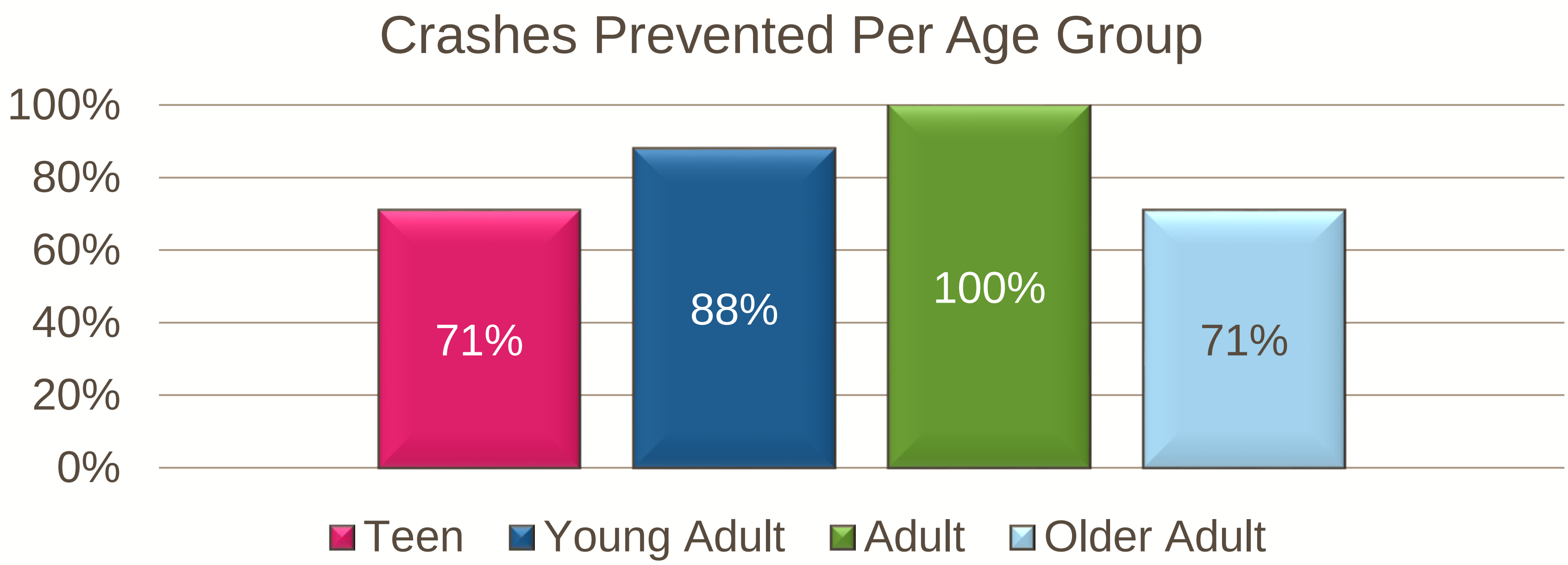
SHRP2 EVENTS WITH RADAR DATA

- Reviewed all rear-end events for reliable radar data



AEB EFFICACY AMONG RISKY DRIVERS

- Overall AEB was very effective
  - Prevented **80%** of crashes (n=32 of 40)
  - Higher than previously reported (14-57%)



AEB EFFICACY AMONG RISKY DRIVERS

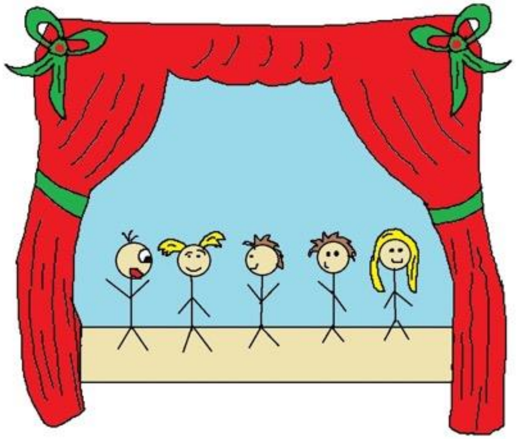
- Teen crashes occur at higher speeds
  - AEB onset/deceleration insufficient to stop vehicle

Group	Age Range (yrs)	Impact Velocity (kph)	Median Impact Velocity (kph)
Teen	16-19	29 ± 5	31
Young Adult	20-24	17 ± 4	12
Adult	35-54	6 ± 1	6
Older	70+	17 ± 5	14

These data provide further support for customized driver assist systems

WHAT WOULD YOU DO?

- Your 12 year old needs a ride from school to play practice.
  - Do you let her ride in a self-driving Uber?



METHODS

3 parent focus groups (N=19)

- Driving simulator in two modes
- Private interviews
- Moderated group discussion

Interviews of 8-16 year old children (N=14)

- Simulator in self-driving mode
- Discuss when, how they'd use HAVs

Parents 30-53; mean=44
Children 8-16; mean=11

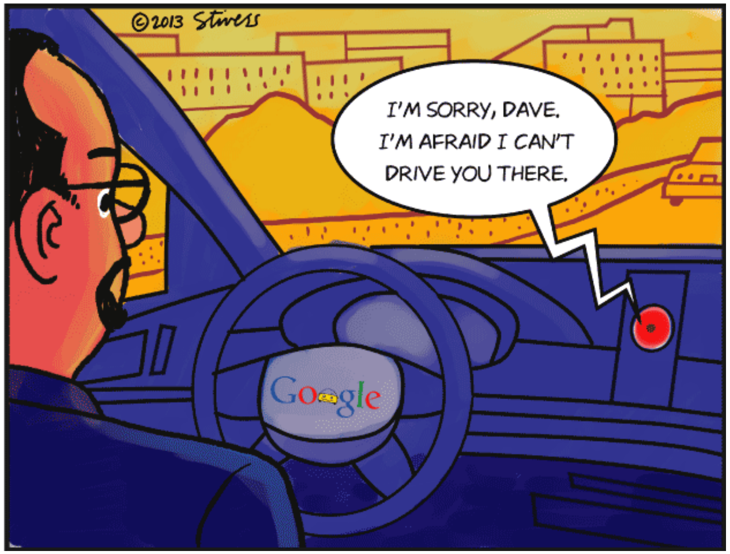
Work led by Patrice Tremoulet
Published in *Human Factors*, 2019

PARENT INTERVIEWS

- 80% felt comfortable & safe entire time
  - But 55% reported urge to take control!
  - They would expect to take control using brake, accelerator, or steering wheel “similar to disengaging cruise control”
- Level of comfort using self-driving vehicles
  - 60% comfortable alone or with a child
  - 25% comfortable allowing a child to use alone

CHILDREN EXPECT TO TAKE CONTROL BY…

- Using brake pedal (33%)
- Using a button *"like on school buses"* (33%)
- Talking to the vehicle (21%)



DESIRED SAFETY FEATURES

- Seat-belt:
  - Verification/checking for use
  - Fastening assistance
- 'Intruder alert' notification
- Safety-lock preventing manual mode
- Secure passenger ID system
- Emergency stop switch

OTHER FEATURES

- Parental controls/monitoring
  - Call or establish video link with passengers
  - Only parent can set or modify destination
  - Automatic notification when child arrives
  - Access trip info (speed, location) remotely
- Ability for vehicle to send alerts to previously identified ‘emergency contacts’

RESPONSIBILITY = OPPORTUNITY

- HAVs coming fast…
- Few people thinking about child passengers
  - **Responsibility** to consider children up front
  - **Opportunity** to pioneer a challenging topic
  - Parent and child inputs needed to inform
    - New policies
    - HAV safety feature design and development
    - Best practices/recommendations
    - Societal / infrastructure requirements

MENU OF RESEARCH STUDIES

- Teen drivers are in crash types relevant for AEB
  - Inform driver-specific ADAS features
  - For Teens – emphasize rear end crashes, road departures
- Novel method for evaluating effectiveness of AEB for different age groups
  - Most realistic simulations to date
  - Less effective at preventing teen crashes – higher velocity
  - Need to consider AEB + FCW
- Don’t forget about kids in highly automated vehicles
  - Consider usability and human factors

ACKNOWLEDGEMENTS

CChIPS | Center for Child Injury Prevention Studies

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