VIRGINIA TECH

Funded By

SAFE-D
SAFETY THROUGH DISRUPTION

Exploring human-vehicle communication to balance transportation safety and efficiency: A naturalistic field study of pedestrian-vehicle interactions

Micah Roediger
Jeffery Hickman
E. Scott Geller

August 29th, 2018

VIRGINIA TECH

Introduction

- Pedestrians are vulnerable
- Solution: autonomous vehicles
- Pedestrian-vehicle interactions

VIRGINIA TECH

Research Questions

- Will pedestrian behavior differ when a vehicle is perceived as autonomous ("self-driving")?
- What are the factors that predict yield behavior?
  - Individual differences
  - Situational factors

Methodology: Design (2x2x2)

	No Think-Aloud Protocol	
	Sign	No Sign
Route 1	3	1
Route 2	4	2

	Think-Aloud Protocol	
	Sign	No Sign
Route 1	3	1
Route 2	4	2

VIRGINIA TECH™

Experimental Equipment

VIRGINIA TECH

Experimental Equipment

Experimental Equipment

Methodology: Participants

- 5 Males & 5* Females
- Accompanied by experimenter as mandated by IRB

Data Reduction

- Video data was coded in Hawkeye, a proprietary software from the Virginia Tech Transportation Institute

VIRGINIA TECH

Analysis

- Descriptive
  - Differences in yield behavior for:
    - Driving condition
    - Narration
    - Drive route
  - Differences in driver or pedestrian behavior for:
    - Driving condition
    - Narration
- Regression
  - Data structure is nested (events ➡ drivers)
  - Multilevel logistic regression analysis

VIRGINIA TECH

Data Cleaning

- 1,808 coded events
- 29 bicyclist events (removed from analysis)
- 41 events removed for pedestrians not attempting to enter roadway or low frequency yield behavior
- 1,738 coded events used in analysis

VIRGINIA TECH

Reliability: Percent Agreement

- 100 events
- Percent agreement
- Range
  - 56-100%
- 80% is generally accepted reliability
- Reliability over 80% for 43/45 variables
- Pedestrian path obstruction (56%)
- Pedestrian assertiveness (66%)

VIRGINIA TECH

Descriptive Analysis: Yield Behavior

		Yield	Failure to yield	χ^2(df)
Driving context	No sign	763	86	1.4 (1)
	Sign	783	106	
Narration	No think-aloud	762	97	0.1 (1)
	Think-aloud	784	95	
Drive Route	Route one	990	123	0.1 (1)
	Route two	556	69	

*Significant at alpha 0.05

VIRGINIA TECH

Descriptive Analysis: Driving Condition

		No sign	Sign	χ^2(df)
Driver hand position	Top of wheel	446	339	41.7 (2)*
	Side of wheel	36	28	
	Bottom of wheel	367	522	
Driver wave through	Yes	79	59	4.2 (1)*
	No	770	830	

*Significant at alpha 0.05

Descriptive Analysis: Narration

		No think-aloud	Think-aloud	χ^2(df)
Driver eye contact	Yes	795	779	7.8 (1)*
	No	64	100	

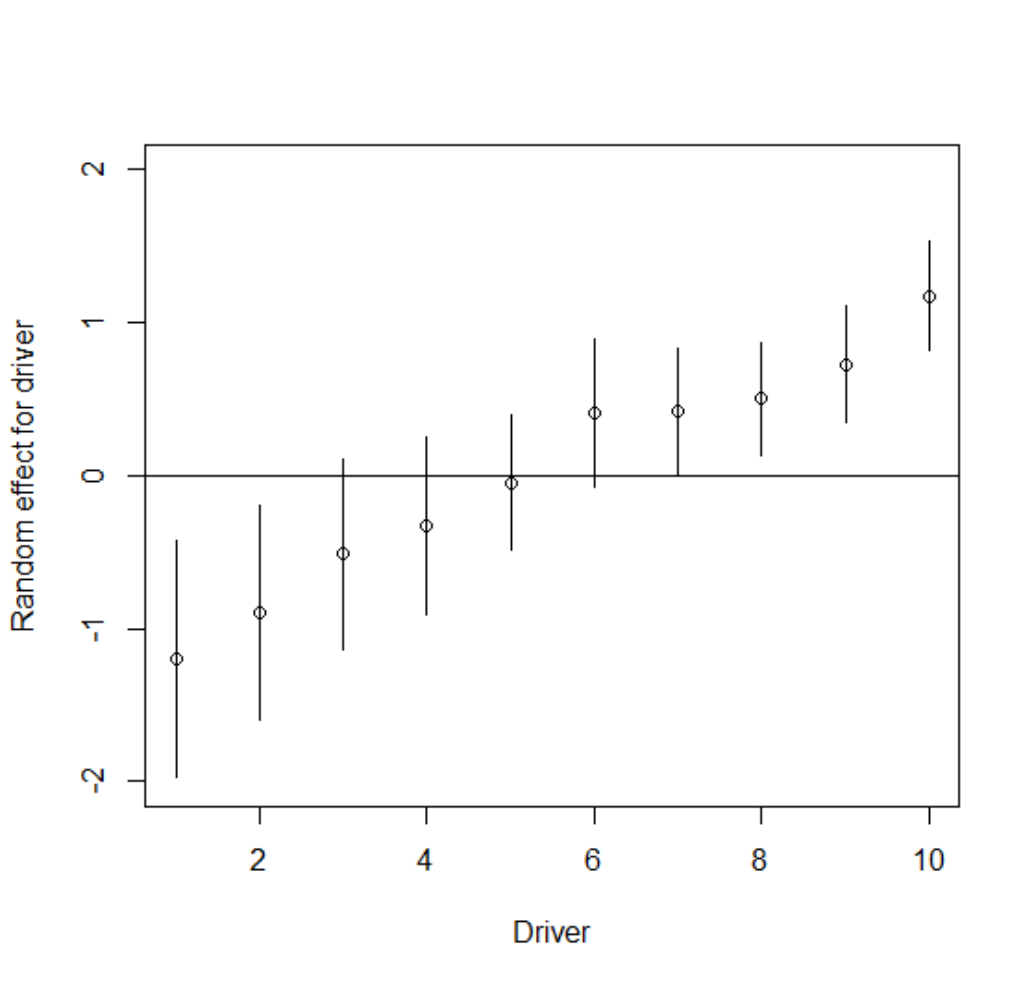
*Significant at alpha 0.05

VIRGINIA TECH

Unconditional Means Model

Fixed effects	Estimate	Standard error
Intercept	-2.30	0.26
Random effects	Variance	Standard deviation
Driver	0.61	0.78

Driver Random Effects Caterpillar Plot



VIRGINIA TECH

Regression Model

- Inclusion criteria
  - All categories with greater than 5% of overall data
  - Remove correlations greater than 0.7
- Coefficient interpretation criteria
  - Large effect
    - 4.1387
  - Medium effect
    - 2.4972

VIRGINIA TECH

Regression Model

Fixed effects	Odds Ratio	Z-score	*p*-value	Effect size
Intercept	0.15	-2.77	0.01	
Driver Expression (eye contact vs. none)	0.02	-11.64	0.00*	Large
Pedestrian Expression (eye contact vs. none)	3.31	3.35	0.00*	Medium
Traffic Control (stop sign vs. none)	0.06	-3.21	0.00*	Large
Factor Affecting Driver Path (yes vs. none)	0.16	-5.77	0.00*	Large
Factor Affecting Pedestrian Path (yes vs. none)	3.85	3.57	0.00*	Medium
Vehicle in Opposing Lane (yes vs. no)	0.35	-2.77	0.01*	Medium
Pedestrian Distance (0 feet vs. in crosswalk)	16.32	5.09	0.00*	Large
Pedestrian Distance (0-5 feet vs. in crosswalk)	16.03	5.38	0.00*	Large
Pedestrian Distance (5-10 feet vs. in crosswalk)	76.02	7.82	0.00*	Large

*Significant at alpha 0.05

VIRGINIA TECH

Discussion

- Hand signals
- Drivers alter visible behaviors in the sign condition
- Drivers appear distracted in the narration condition
- Driver speed, pedestrian distance, pedestrian assertiveness
- Right-of-way
- Yield signs
- Path obstructions
- Individual differences

VIRGINIA TECH

Limitations

- Video
  - Field of view
  - Resolution
- Audio
- Field study
- Human error

VIRGINIA TECH

Future Research

- Qualitative analysis
  - Current data
  - Driver centered
  - Pedestrian centered
- Alter equipment
  - Cameras
  - Radar
  - LiDAR
- Deep learning algorithms
  - Convolutional neural networks

Special Thanks

Center for Applied
Behavior Systems
(CABS)
Research Assistants:
Annie Eick &
Christine Fuance