

# Development and Evaluation of Vehicle to Pedestrian (V2P) Safety Interventions

- Duke University
  - Mary Cummings (P. I.)
  - Lixiao Huang
- University of North Carolina
  - Michael Clamann



# Background

- Pedestrian deaths have steadily risen in the past two decades with approximately 6000 people killed annually in 2016 and 2017<sup>[1]</sup>.
- The top three causes of these fatalities<sup>[2-3]</sup>:
  - (1) Speeding
  - (2) Failing to yield
  - (3) Distractions such as electronic devices**

[1] National Center for Statistics and Analysis (2018). 2017 Fatal Motor Vehicle Crashes: Overview. NHTSA. Washington, DC, Department of Transportation.

[2] Swanson, E. D., M. Yanagisawa, W. Najm, F. Foderaro and P. Azeredo (2016). Crash Avoidance Needs and Countermeasure Profiles for Safety Applications Based on Light-Vehicle-to-Pedestrian Communications (Report No. DOT HS 812312). Washington, DC: National Highway Traffic Safety Administration.

[3] Schaper, D. (2017). Distraction, On Street and Sidewalk, Helps Cause Record Pedestrian Deaths. All Things Considered. Washington DC, National Public Radio.

# Background

- Injuries from distracted walking have increased 81% since 2005, with those 16-25 years old affected the most<sup>[4]</sup>.
- Approximately 30% of all pedestrians were observed a distracting activity while crossing in Seattle<sup>[5]</sup>.

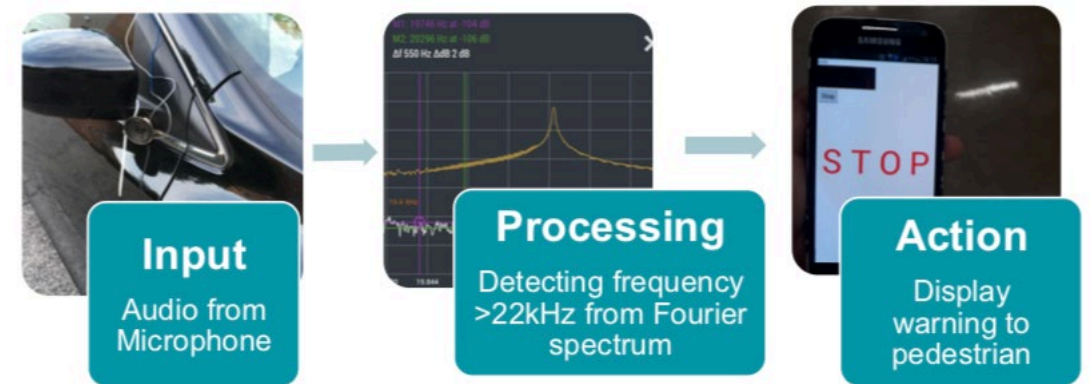


[4] Nasar, J. L. and D. Troye (2013). "Pedestrian injuries due to mobile phone use in public places"

[5] Thompson, L. L., F. P. Rivara, R. C. Ayyagari and B. E. Ebel (2013). "Impact of social and technological distraction on pedestrian crossing behaviour: an observational study." [Injury Prevention](#) 19(4): 232.

# Background

- Vehicle-to-Pedestrian (V2P) alerting system: A communication network that would alert a pedestrian to one or more oncoming cars<sup>[6-7]</sup>.



- Ignorance emergence alerts<sup>[8]</sup>
- Alert fatigue<sup>[9]</sup>
- Mistrust to alarms<sup>[10]</sup>

[6] Bagheri, M., M. Siekkinen and J. K. Nurminen (2014). Cellular-based vehicle to pedestrian (V2P) adaptive communication for collision avoidance. International Conference on Connected Vehicles and Expo (ICCVE). Vienna, Austria.

[7] Bai, X. and R. Miucic (2018). Vehicle Pedestrian Safety System and Methods of Use and Manufacture Thereof. USPTO, Honda Motor Co., Ltd.

[8] Kar, B. and D. Cochran (2016). Final Report: An Integrated Approach to Geo-Target At-Risk Communities and Deploy Effective Crisis Communication Approaches. Washington DC, Department of Homeland Security.

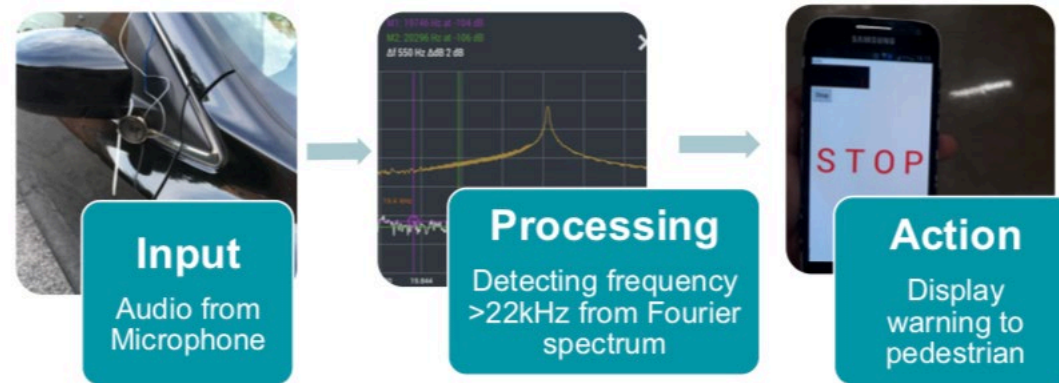
[9] Ancker, J. S., A. Edwards, S. Nosal, D. Hauser, E. Mauer and R. Kaushal (2017). "Effects of workload, work complexity, and repeated alerts on alert fatigue in a clinical decision support system." BMC medical informatics and decision making 17(1): 36.

[10] Zabyshny, A. A. and D. R. Ragland (2003). False Alarms and Human-Machine Warning Systems. Berkeley, CA, UC Berkeley: Safe Transportation Research & Education Center.

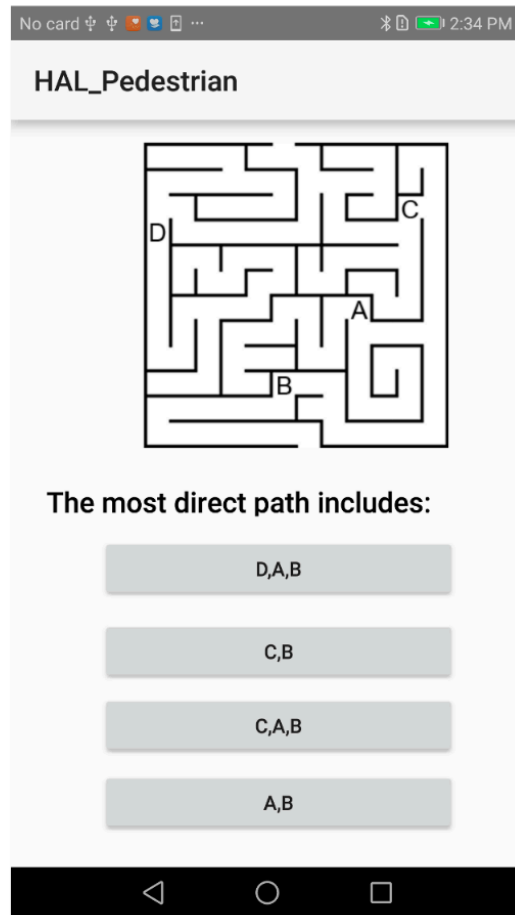
# Research questions

1. Would such a smartphone alert be helpful for distracted pedestrians?
2. How does the degree of reliability of the V2P system influence the pedestrian adoption?
  - A pedestrian alerting system
  - A pedestrian distraction
  - A controlled testing environment

# Pedestrian alerting system



# Experiment Device: Distraction vs. Alert







# Subjects and experimental setups

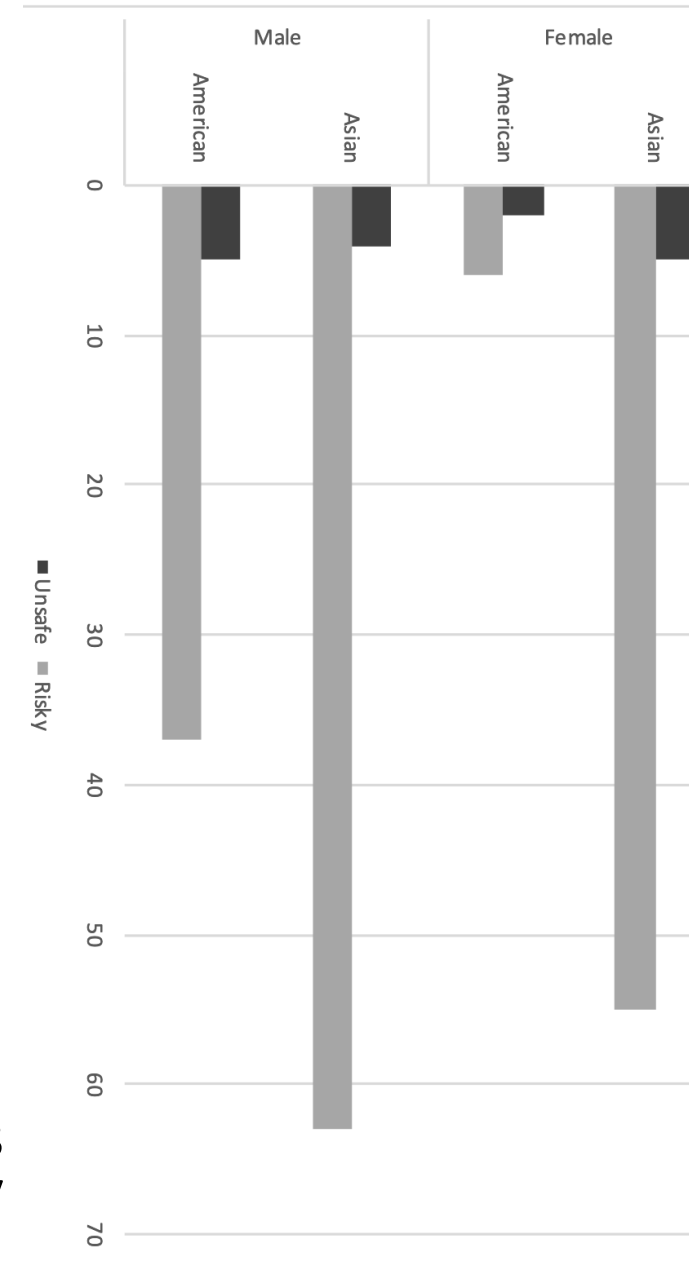
- 30 participants
  - 18 males, and 13 females
  - Ages between 19 and 57 yrs (mean = 27.1, std = 7.7)
  - 15 US-born citizens, and 15 non-US-born
  - 70 % had texting on their phones while walking
  - 35% would text while crossing a street.
- 3 reliability conditions
  - 80%, 90%, and 100 %
- 3 alerting times
  - Early alert activated 260 ft away (7s gap), late alert activated 110 ft away (3s gap), and just-in-time alert between the other two
- 30 trials per subject
  - 5 per reliability and alerting time combination

# Results I

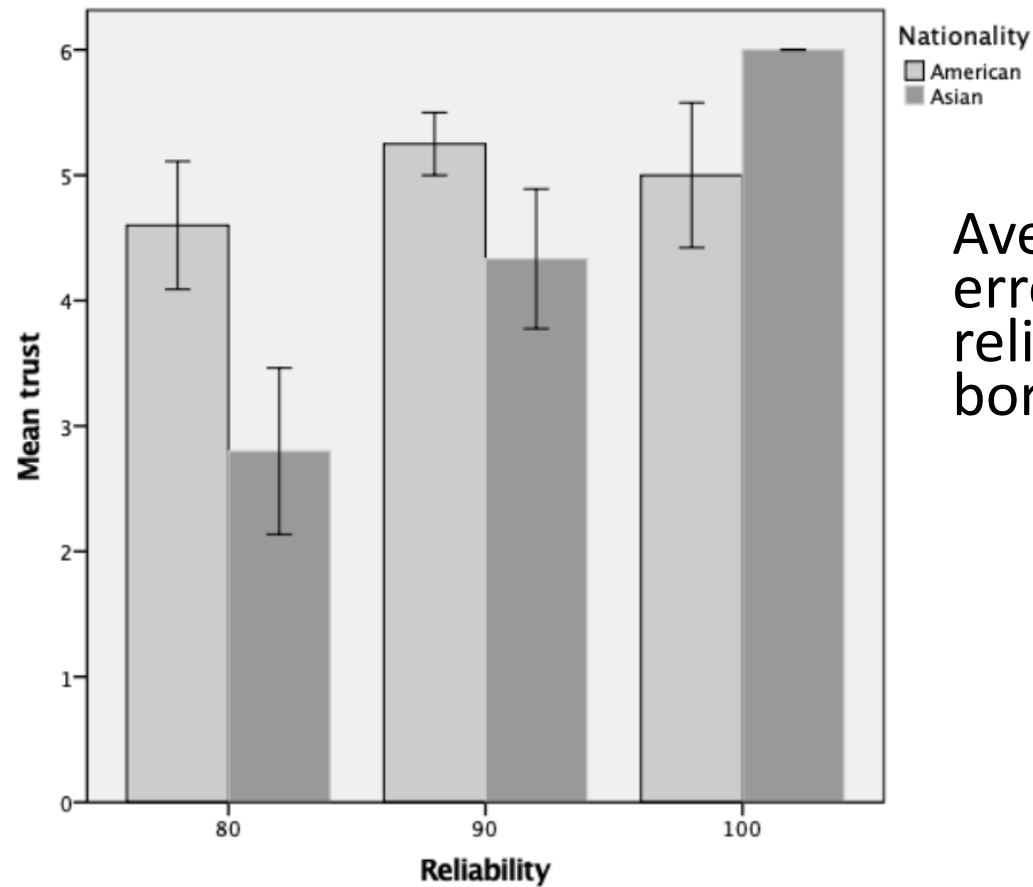
The number of safe vs. risky vs. unsafe crossings as a function of time

|              | Safe | Risky | Unsafe |
|--------------|------|-------|--------|
| Early        | 45   | 0     | 0      |
| Just-in-time | 645  | 161   | 0      |
| Late         | 33   | 0     | 16     |

Risky and unsafe potential pedestrian crossings  
across gender and nationality

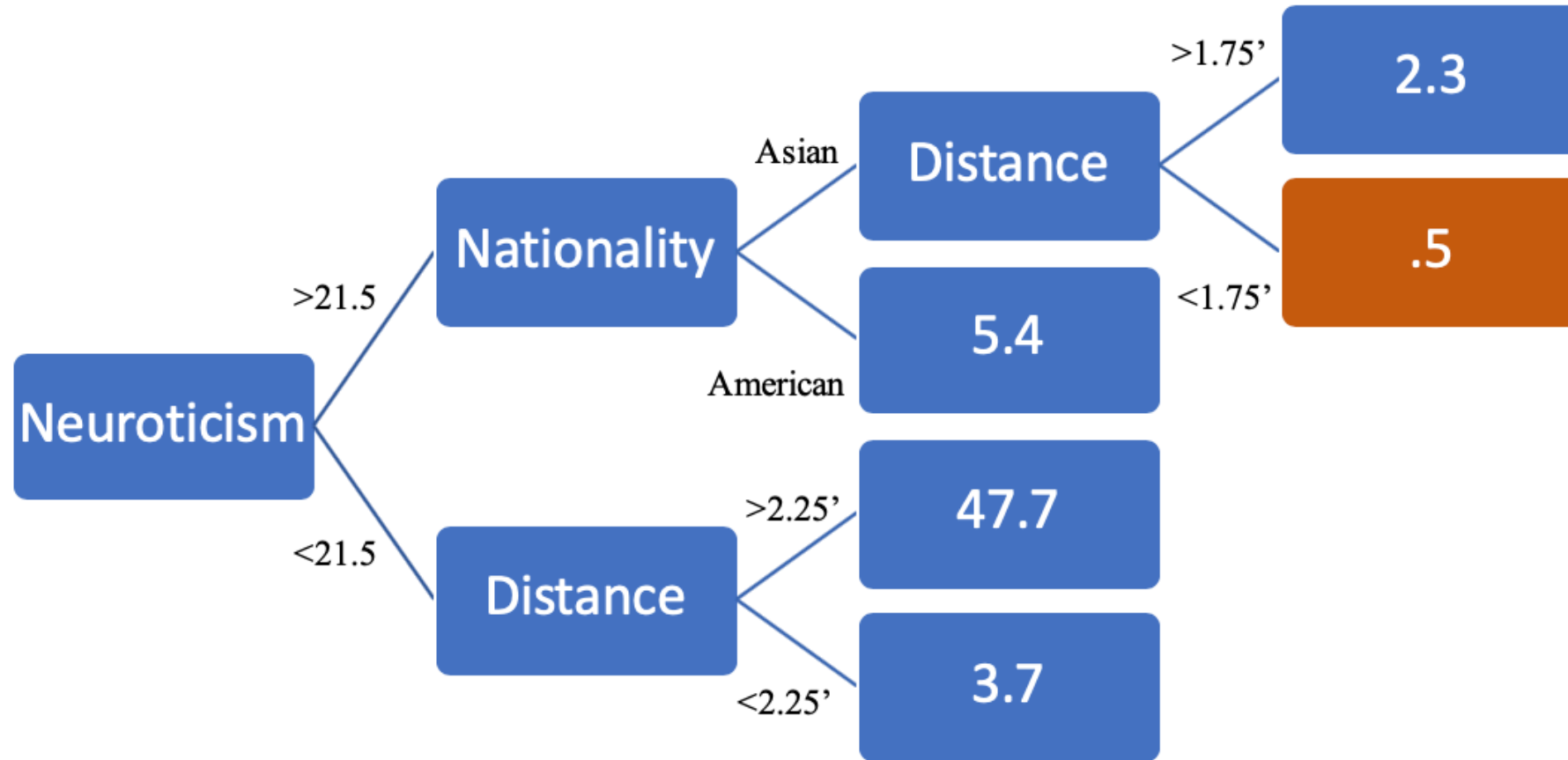


# Results II



Average trust ratings (+/- 1 standard error) for 80, 90, & 100% alert reliabilities for US-born versus non-US-born.

# Results III



Decision tree analysis demonstrating neuroticism scores were a strong predictor of safe vs. risky crossings, with nationality and stopping distances as relatively equally-weighted factors. The terminal nodes with a number represent the safe/risky crossing likelihood of that particular group.

# Conclusions

- 20% of pedestrians in observational studies also ignore any warnings
- Pedestrian interventions are harder than they seem
- Culture matters
- Follow-on research
  - NSF
  - NC State?
  - Future UTC proposal?



# Acknowledgements

- US Department of Transportation's University Transportation Center grant through the University of North Carolina's Collaborative Sciences Center for Road Safety
- Sam True, the director of the North Carolina Center for Automotive Research
- Researchers who worked on this project: Rohini Sharma, Jing Zhou, Ran Wei, Haibei Zhu, Matthew Seong, Daniel Finkelstein, Esko Brummel, Elizabeth Wallace, Ziyi Li, Wenchao Zhu, and Zak Kramer.