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

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Background

- Pedestrian deaths have steadily risen in the past two decades with approximately 6000 people killed annually in 2016 and 2017[1].
- The top three causes of these fatalities[2-3]:

  (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.

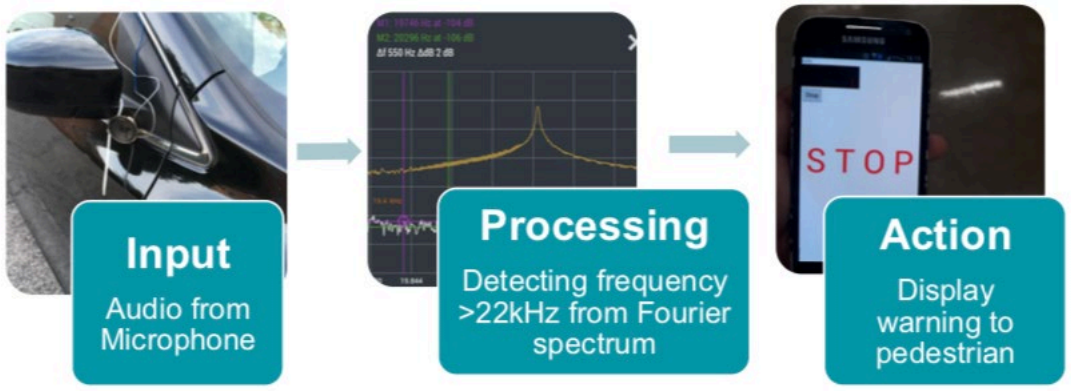
Background

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

[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[6-7].

- Ignorance emergence alerts[8]
- Alert fatigue[9]
- Mistrust to alarms[10]

[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.

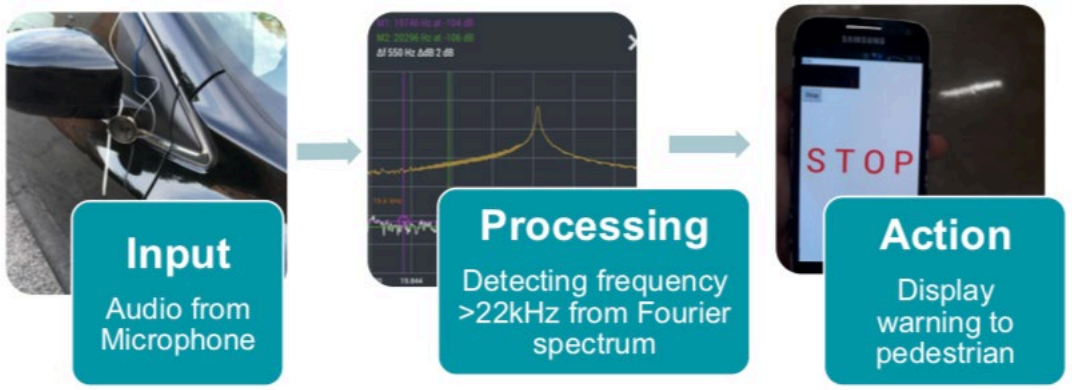
[10] Zabyshny, A. A. and D. R. Ragland (2003). False Alarms and Human-Machine Warning Systems. Berkeley, CA, UC Berkeley: Safe Transportation Research & Education Center.

Research questions

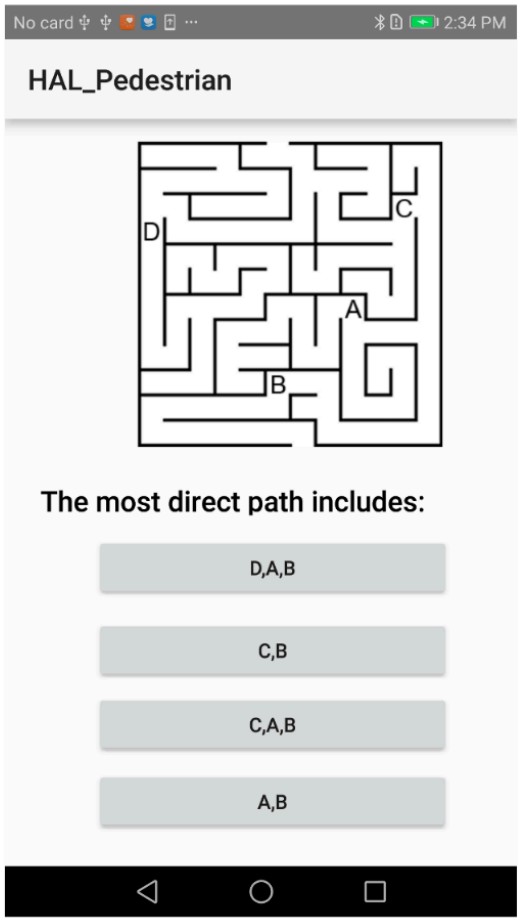
1. Would such a smartphone alert be helpful for distracted pedestrians?
2. How does the degree of reliability of the V2P system influence the pedestrian adoption?

    - A pedestrian alerting system
    - A pedestrian distraction
    - A controlled testing environment

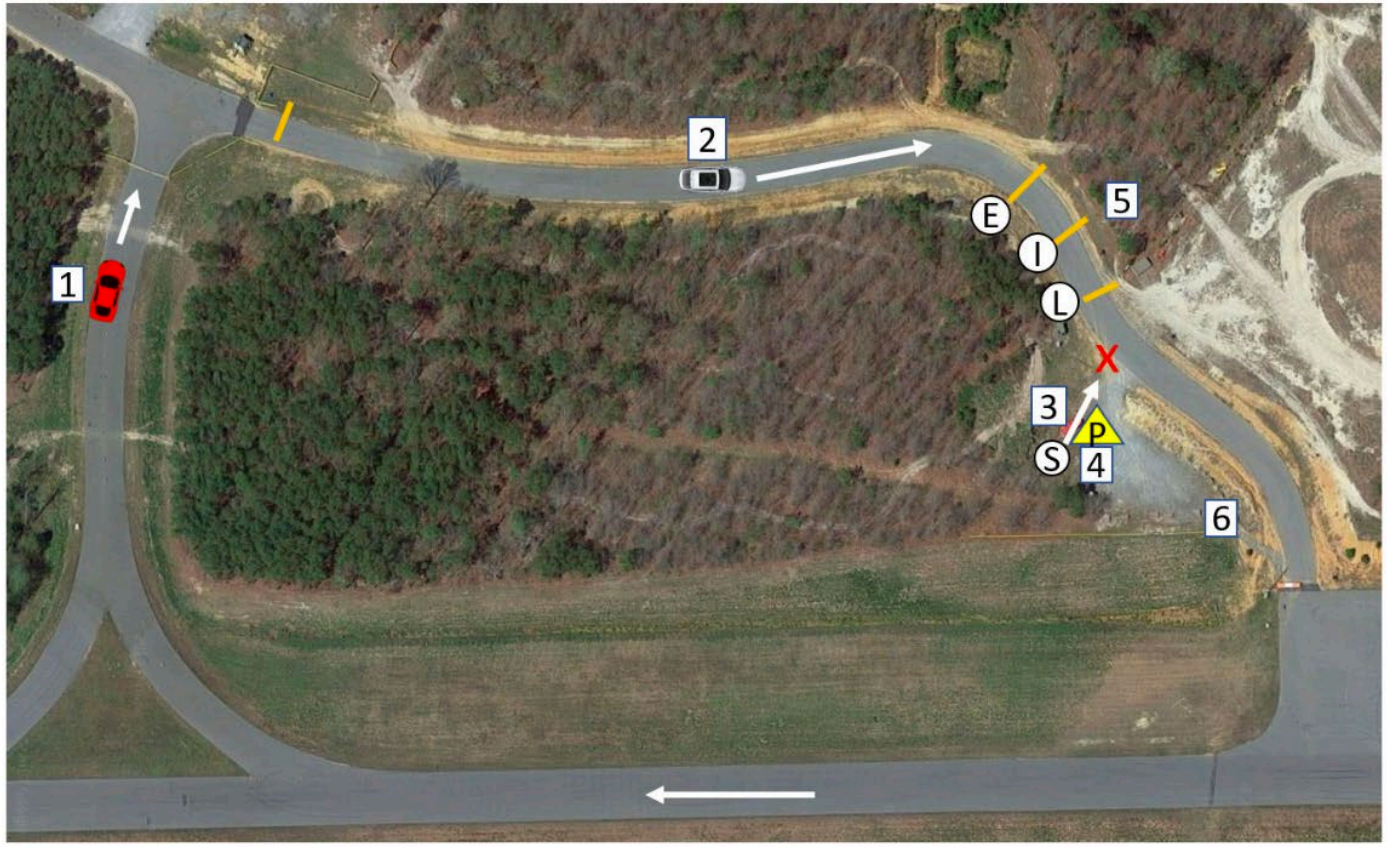
Pedestrian alerting system



Experiment Device: Distraction vs. Alert



Experiment Testbed



Experimenters 1–6 and roles

- 1 Driver 1
- 2 Driver 2
- 3 App alert activator
- 4 Protector
- 5 Car signal person
- 6 Camera person

- Ⓔ Early alert
- Ⓘ Just-in-time alert
- Ⓛ Late alert
- Ⓢ Starting position
- P Participant
- X Crossing point

https://www.youtube.com/watch?v=Zl0bCDXS6VA&feature=youtu.be

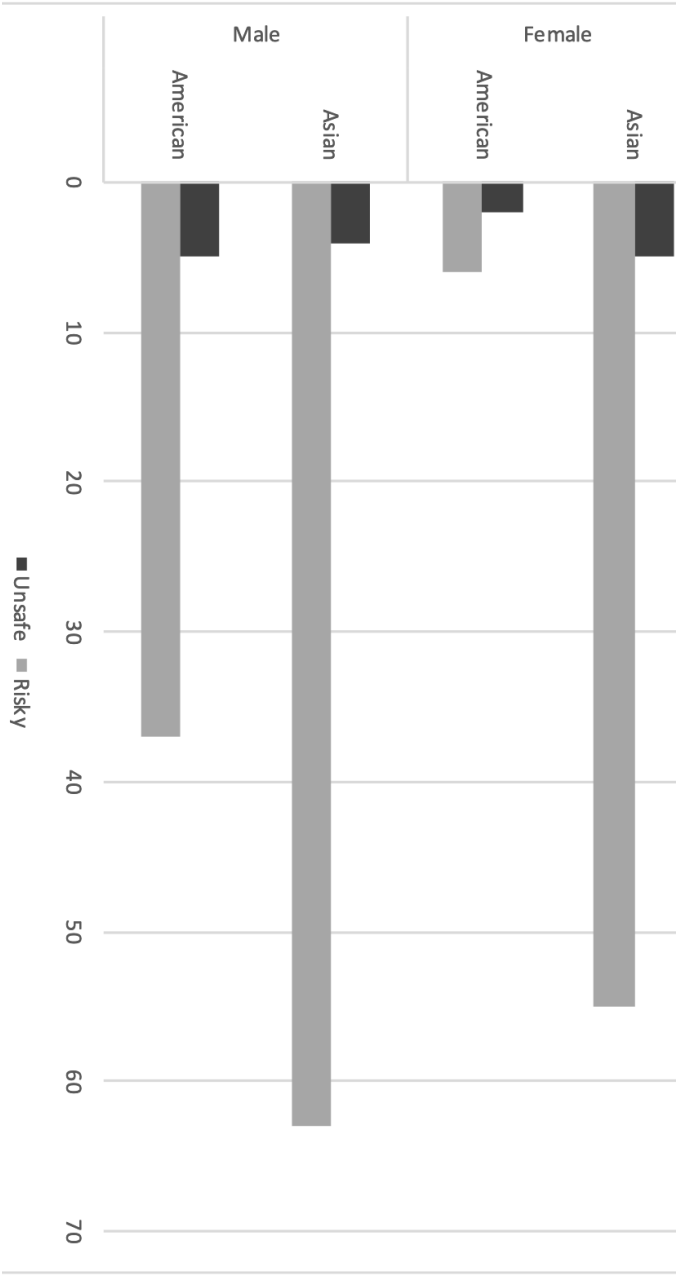
Subjects and experimental setups

- 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

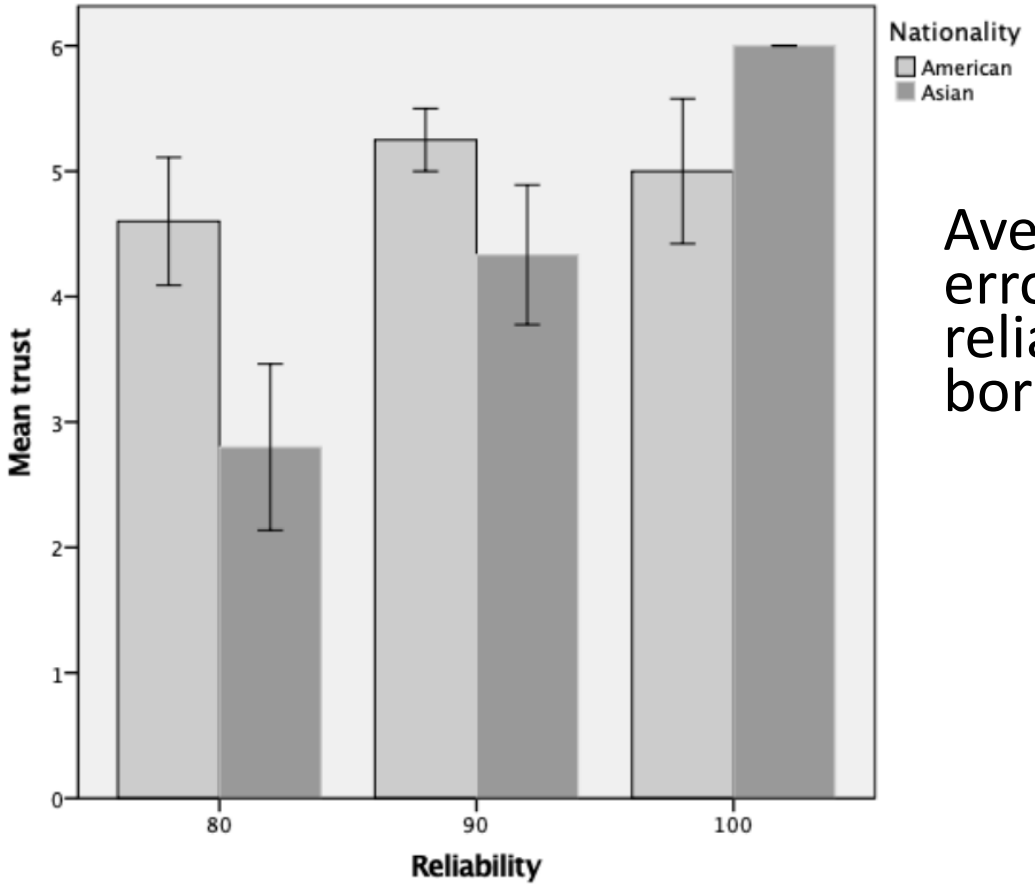
The number of safe vs. risky vs. unsafe crossings as a function of time

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



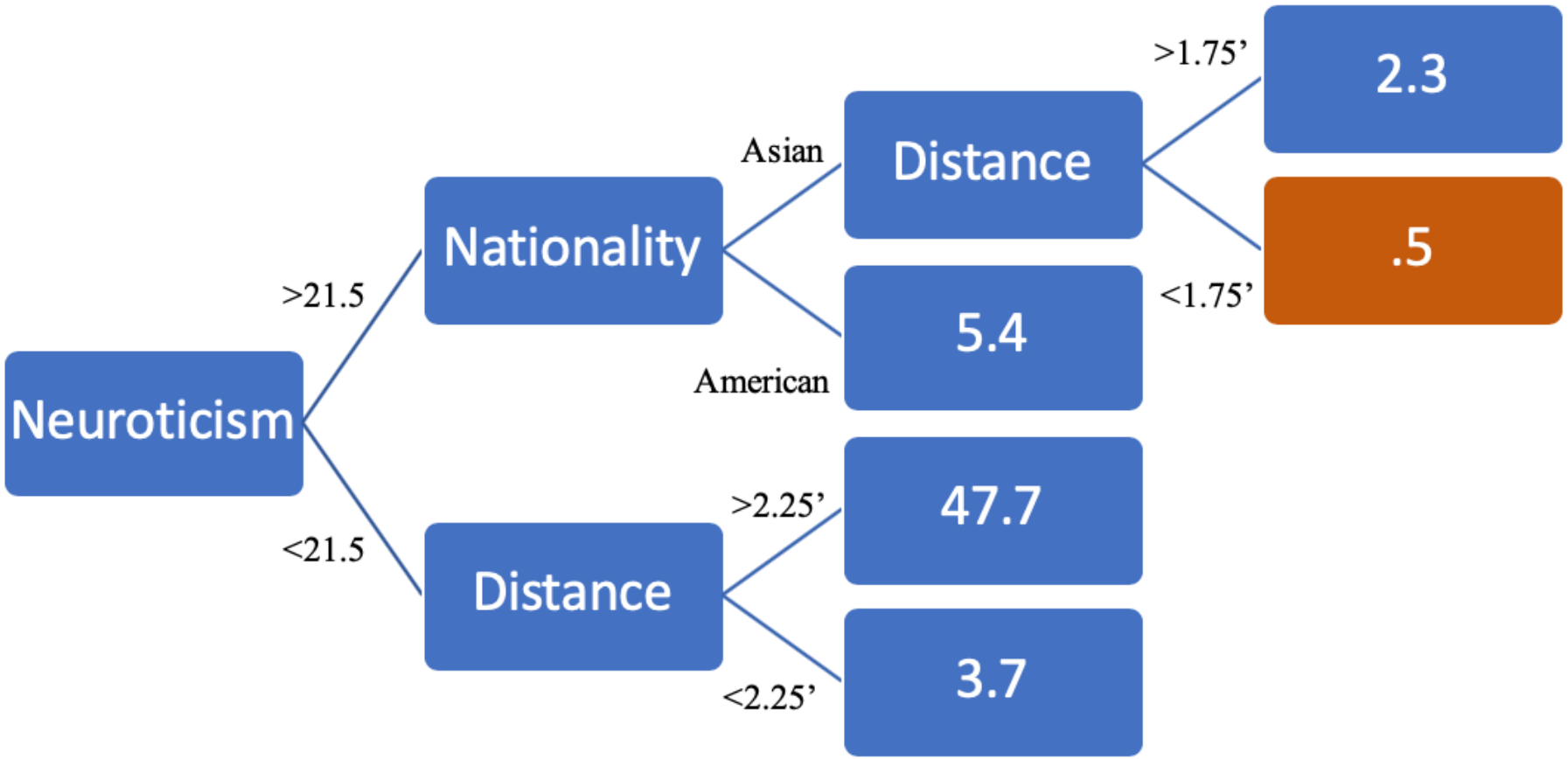
Risky and unsafe potential pedestrian crossings across gender and nationality

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?

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