

Factors influencing road user behaviors at enhanced crosswalks

2026 Texas Pedestrian Safety Forum

Texas Pedestrian Safety Coalition
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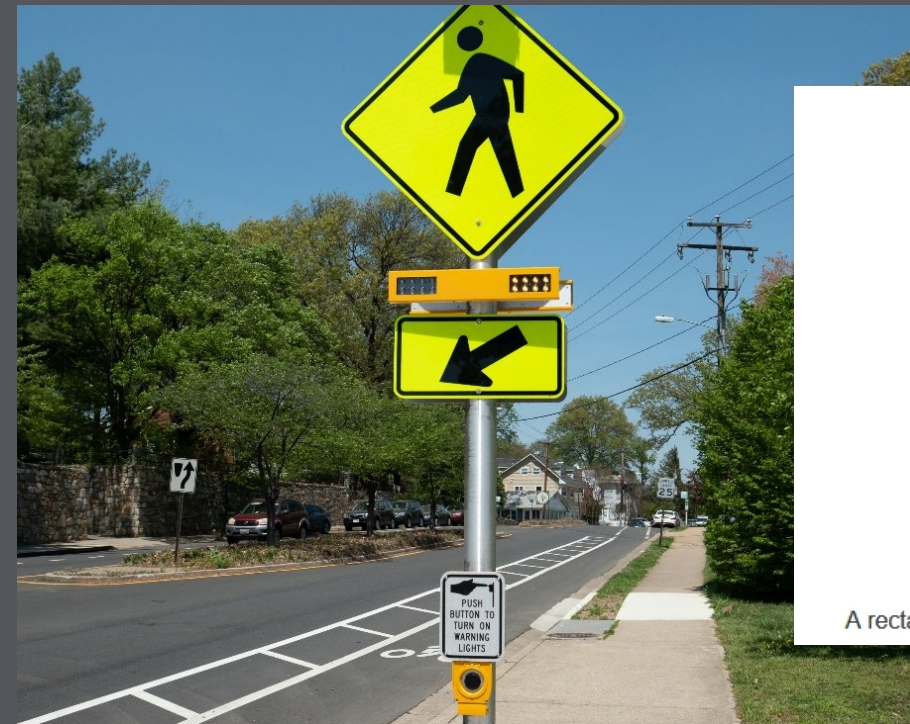
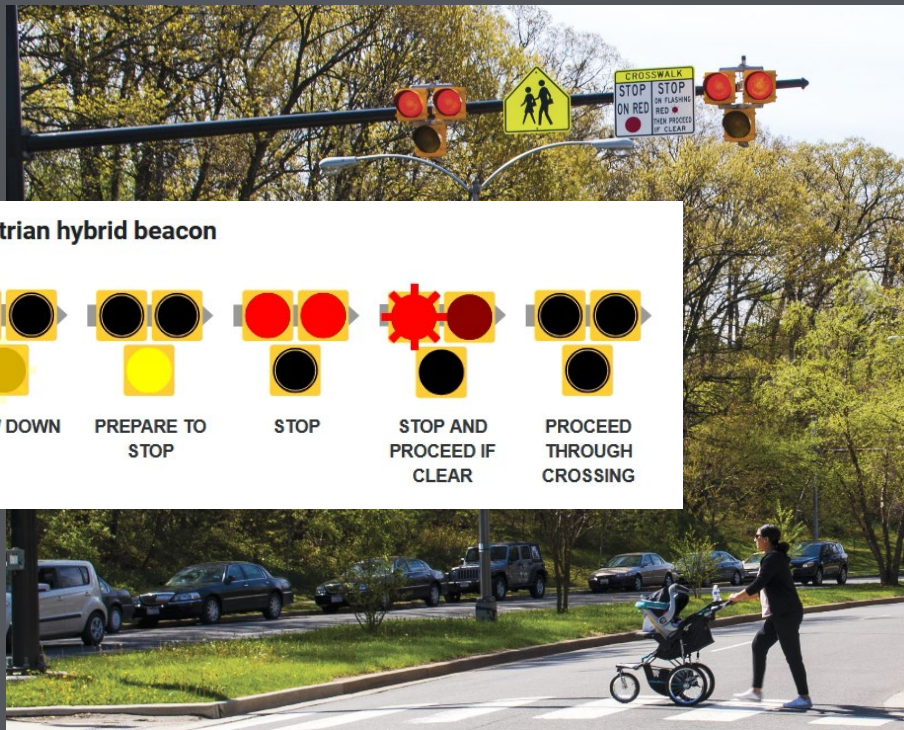


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Introduction

Pedestrian Hybrid Beacons (PHBs) and Rectangular Rapid Flashing Beacons (RRFBs) are known to improve driver yielding to pedestrians



A rectangular rapid flashing beacon, or RRFB

For both devices to be effective:

- ▶ Pedestrians must cross at the designated locations
- ▶ Pedestrians must actuate the device (i.e., push the button)



A man in a white t-shirt stands amidst a vast field of young green corn plants. The plants are densely packed and reach up to his chest. The scene is brightly lit, suggesting a sunny day. The overall tone is one of agricultural productivity and potential.

If you build it, they will come...

...maybe, maybe not!

The origin story of this study....

- Cost of installing devices is not trivial:
PHB: \$230K – \$265K¹
RRFB: \$20K – \$30K²
- NCDOT was interested in knowing why pedestrian usage was low at some locations

Sources:

¹ <https://www.wric.com/news/local-news/richmond/pedestrian-hybrid-beacon-cary-street/>

² <https://carmanah.com/resources/overview-rrfb-cost-effectiveness/>

Two-prong approach

Observational study

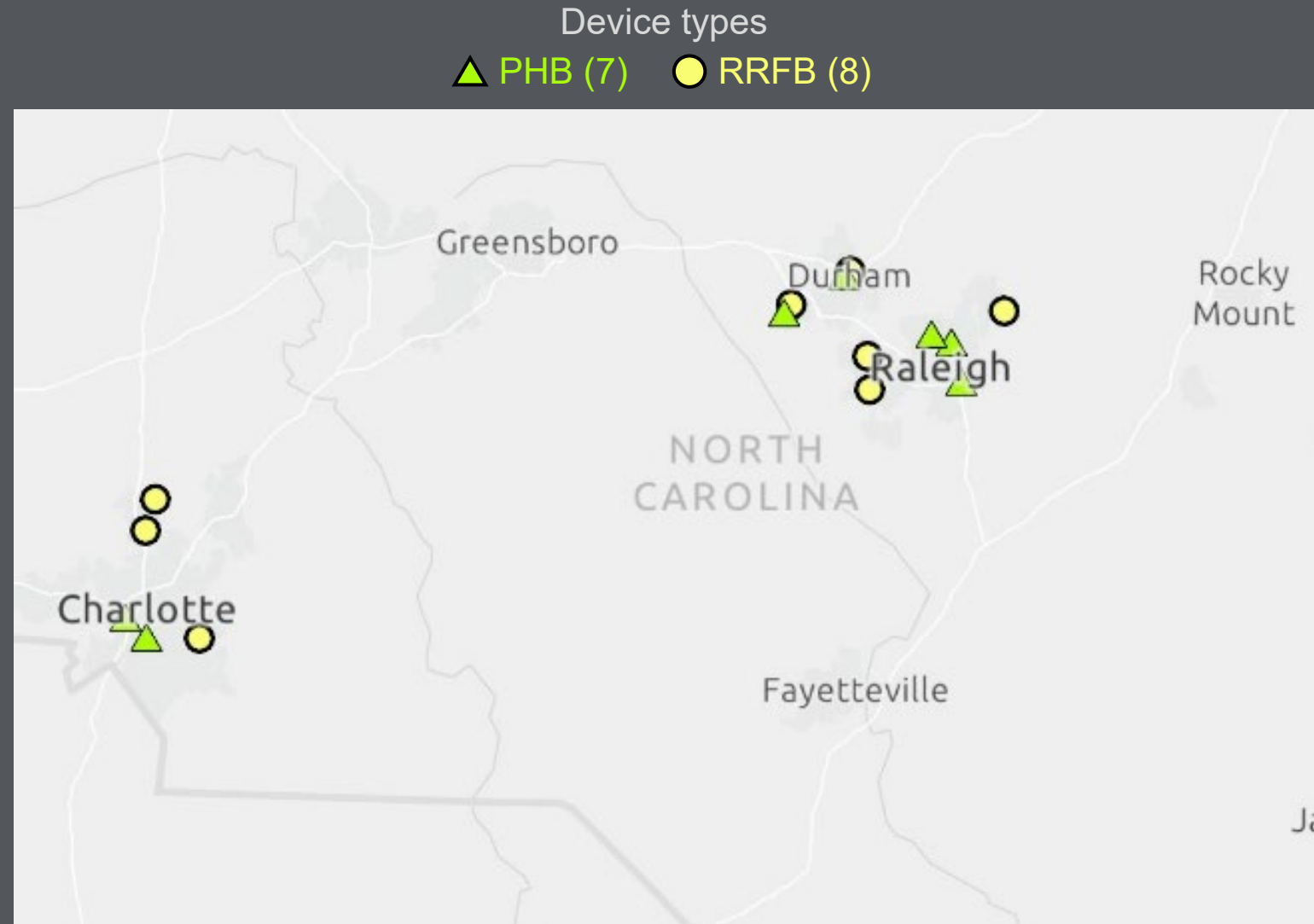
- ▶ 1 week of video footage per site
- ▶ manually coded road user behaviors
- ▶ relate to site characteristics

Pedestrian survey

- ▶ use and motivations regarding devices and context
- ▶ understanding of hardware function
- ▶ contrast with observed behavior

Observational study site locations

- ▶ 15 Locations
 - 7 PHBs, 8 RRFBs
- ▶ Balanced on AADT, cross-section, speed limit, and school zone locations
- ▶ A total of 3,624 crossings available for analysis



Events and behavior types

Observations from video footage

Pedestrian:

Group size: 2
Actuation: Yes

Vehicles:

2 insufficient SSD
1 did not yield
1 yielded



Events and behavior types (continued)

Pedestrian outside crosswalk
Out of crosswalk: yes



Pedestrian coded as vague behavior
28 Vehicles coded as with insufficient SSD



Events and behavior types

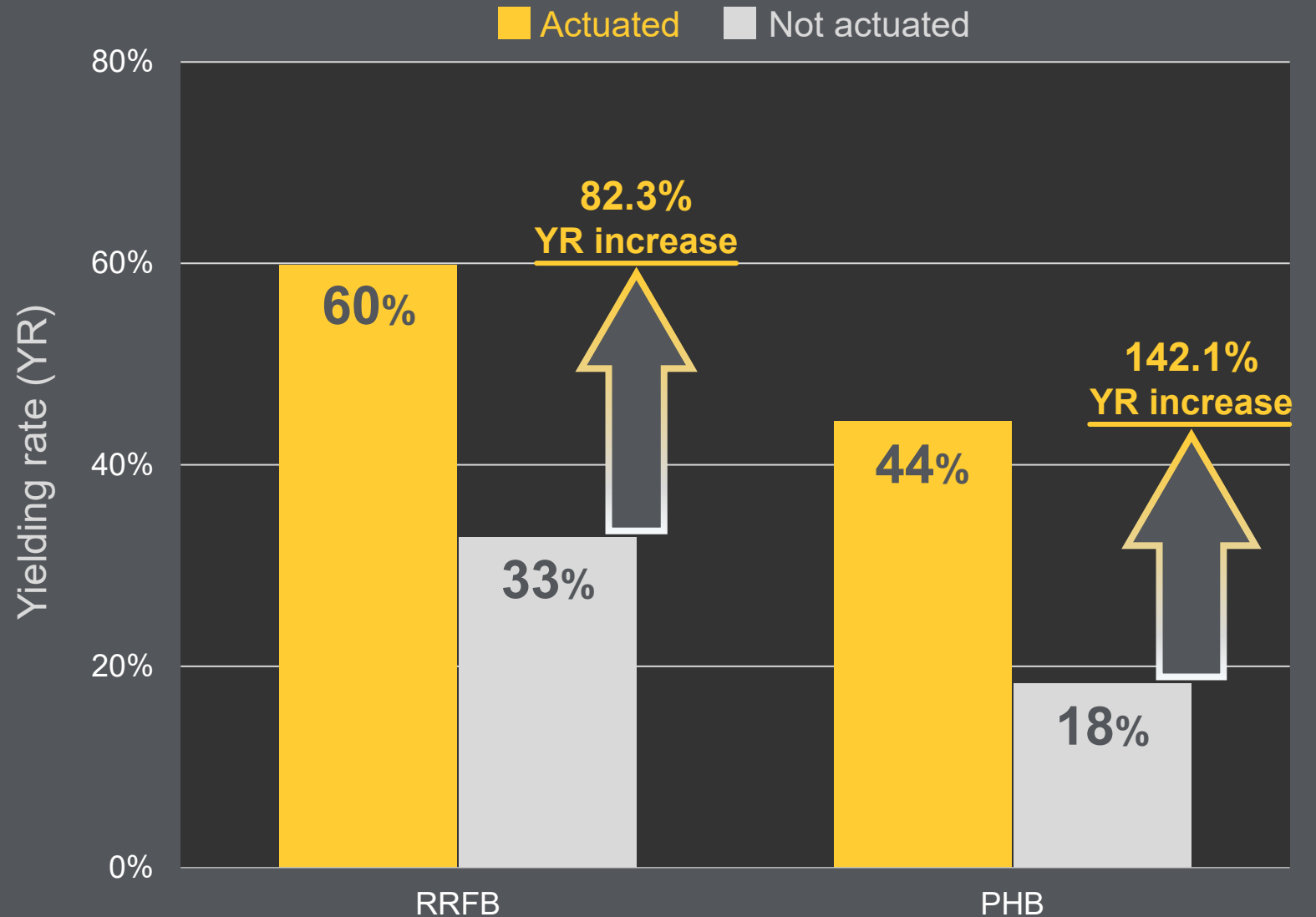
Observations from data coding and QC

Exemplary non-human pedestrian:

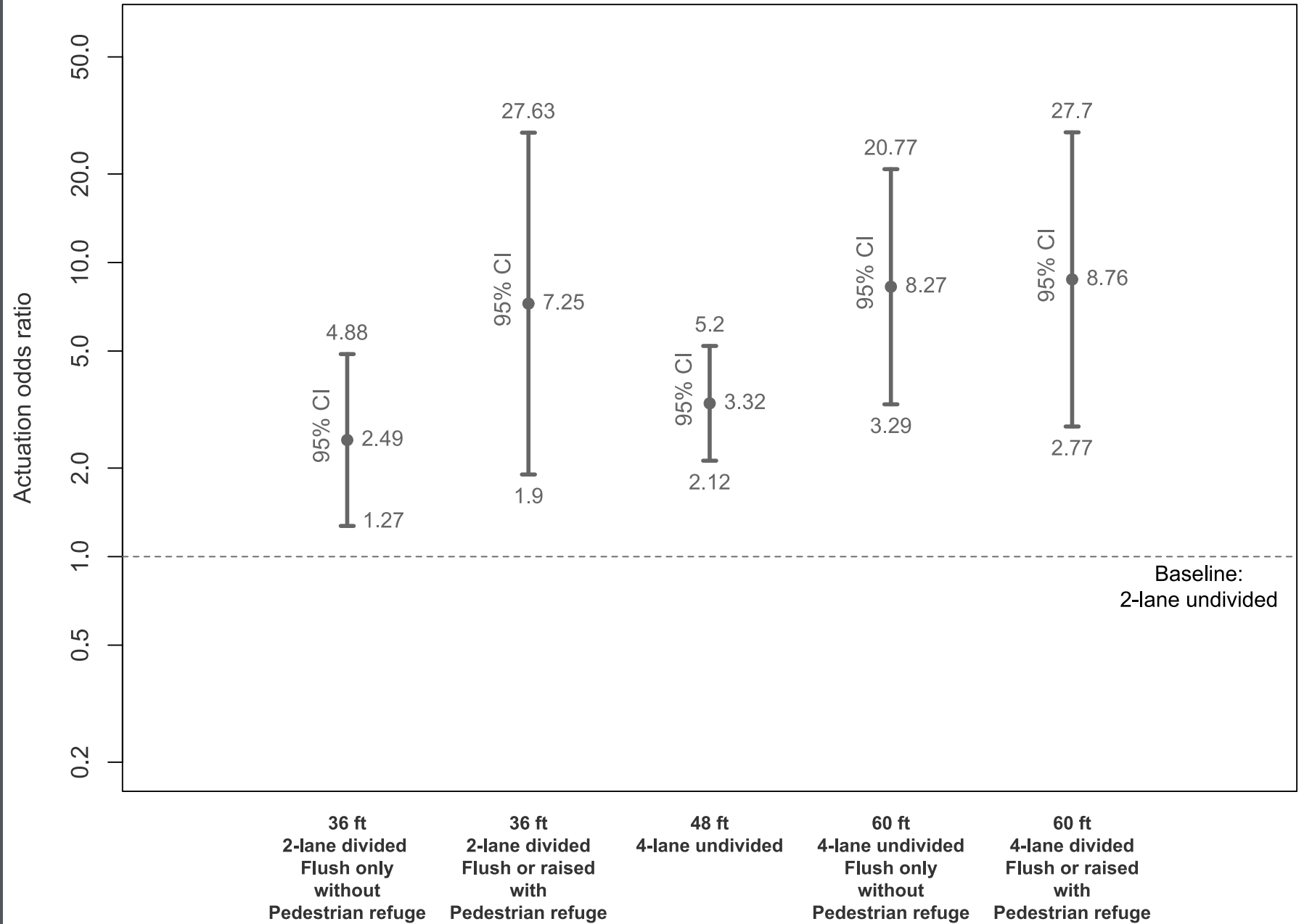


Observational study results

- ▶ RRFBs were actuated by 80% of pedestrians, while PHBs were actuated by 56%
- ▶ Yielding rates were higher when devices were actuated

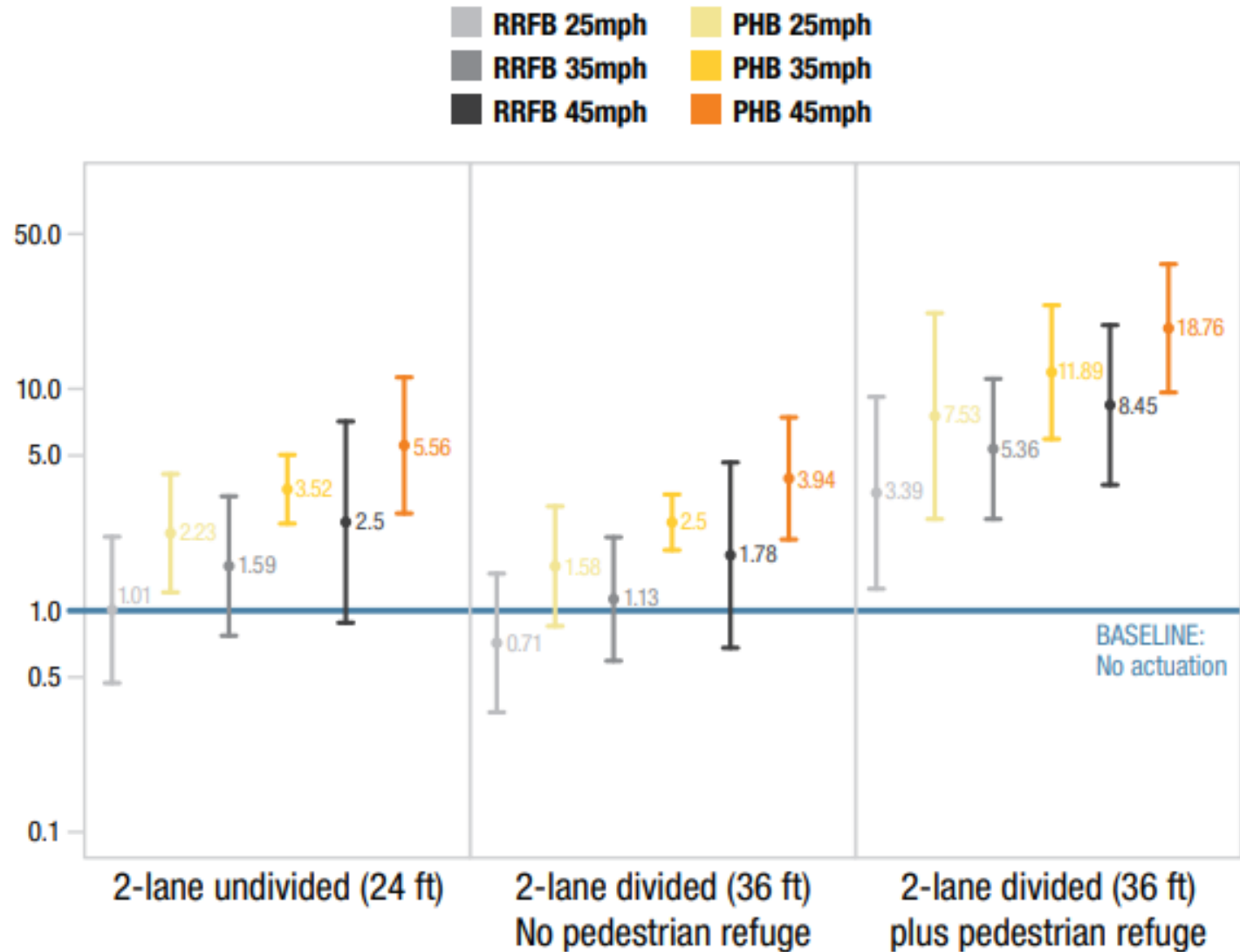


Results (continued)



Results (continued)

Effects of actuation on driver yielding (as odds ratio) by cross section, speed limit, and device type





Factors that increased odds of actuation

Device

↑ 141% at RRFBs compared with PHBs

Geometry

↑ between 149% and 776% at wider crossings + median or refuge island

↓ 73% when the sidewalk is missing on the far side of the crossing

Context

↑ at school zones and midblock locations

↑ during periods with more traffic and for larger groups of pedestrians

Factors that increased odds of driver yielding

Device actuation

↑ up to 1,780% at PHBs and up to 750% for RRFBs when actuated

Pedestrian refuge island

↑ 240% when refuge island present, given the device is actuated

Context

↑ at school zones

↑ at lower AADT locations and during periods of lower traffic

↑ for larger groups of pedestrians



Survey of pedestrians

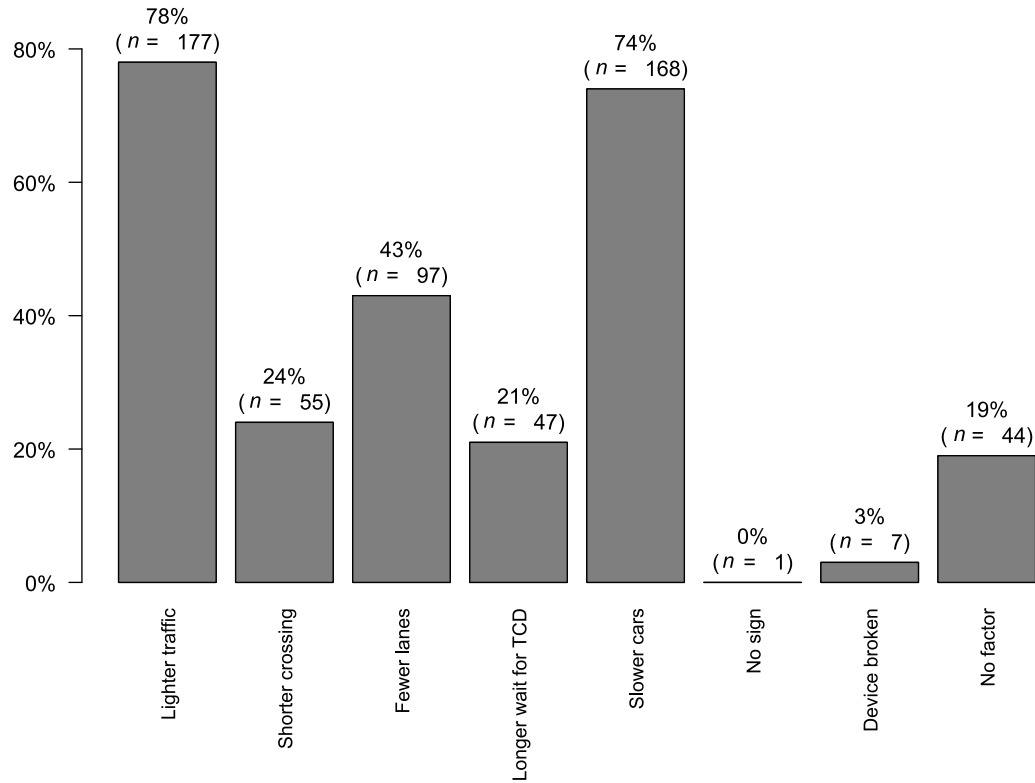
Group A = actuated, crossed with device signaling
 Group B = did not actuate, crossed when device not signaling
 Group C = did not actuate, crossed with device signaling

Variable	Group A (n = 228)	Group B (n = 58)	Group C (n = 57)	Total (n=343)
Age				
18–21	47 (21%)	9 (16%)	14 (25%)	70 (20%)
22–35	96 (42%)	25 (43%)	27 (47%)	148 (43%)
36–50	33 (14%)	6 (10%)	4 (7%)	43 (13%)
51–65	45 (20%)	15 (26%)	9 (16%)	69 (20%)
65+	6 (3%)	3 (5%)	2 (4%)	11 (3%)
Unknown	1 (0%)	0 (0%)	1 (2%)	2 (1%)
Gender (Perceived)				
Male	94 (41%)	31 (53%)	16 (28%)	141 (41%)
Female	133 (58%)	27 (47%)	41 (72%)	201 (59%)
Uncertain	1 (<1%)	0 (0%)	0 (0%)	1 (<1%)

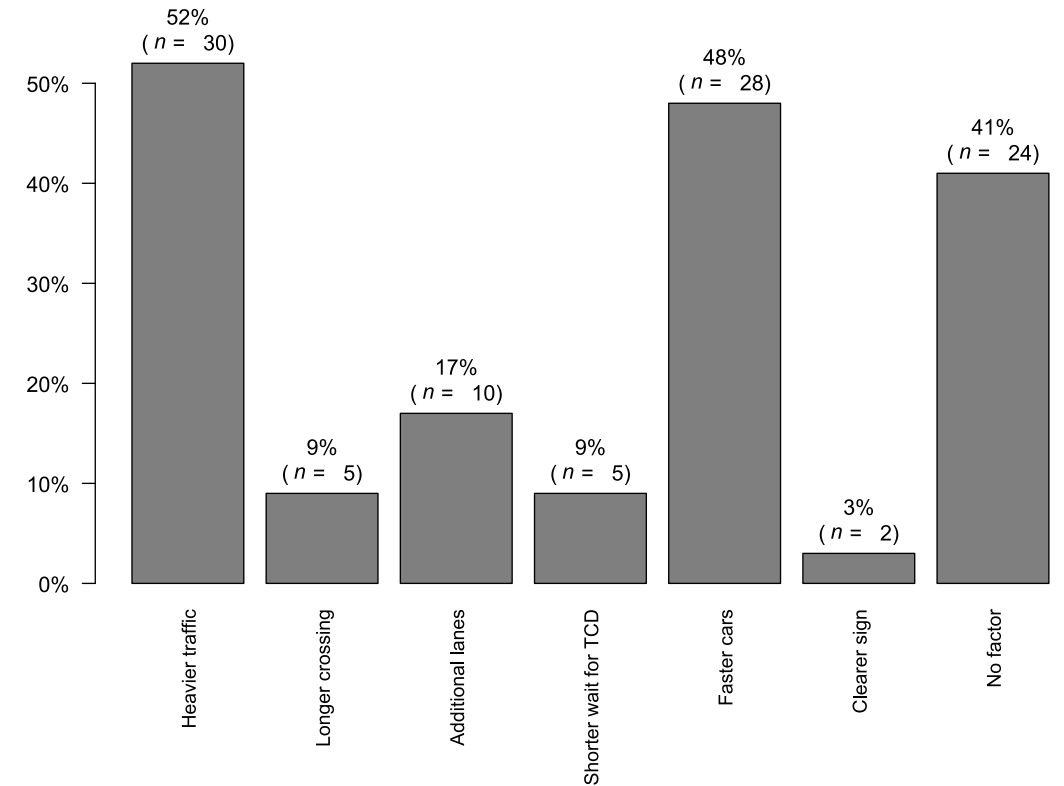
Variable	Group A (n = 228)	Group B (n = 58)	Group C (n = 57)	Total (n=343)
Walking frequency				
Every day	12 (5%)	0 (0%)	1 (2%)	13 (4%)
Almost every day	184 (81%)	36 (62%)	47 (82%)	267 (78%)
At least once a week	30 (13%)	21 (36%)	9 (16%)	60 (17%)
At least once a month	1 (<1%)	1 (2%)	0 (0%)	2 (1%)
>1 time per month	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Don't know	1 (<1%)	0 (0%)	0 (0%)	1 (0%)
Trip purpose				
Work or school	73 (32%)	8 (14%)	17 (30%)	98 (29%)
Exercise	102 (45%)	31 (53%)	26 (46%)	159 (46%)
Personal chores	51 (22%)	14 (24%)	11 (19%)	76 (22%)
Other	2 (1%)	5 (9%)	3 (5%)	10 (3%)
Current trip length				
<10 min	114 (50%)	23 (40%)	36 (63%)	173 (50%)
10–30 min	99 (43%)	32 (55%)	17 (30%)	148 (43%)
>30 min	15 (7%)	3 (5%)	3 (5%)	21 (6%)
Unknown	0 (0%)	0 (0%)	1 (2%)	1 (<1%)

Survey of pedestrians (continued)

Group A = actuated, crossed with device signaling
Group B = did not actuate, crossed when device not signaling
Group C = did not actuate, crossed with device signaling



Stated factors that would reduce chances of actuation in Group A (n = 228)

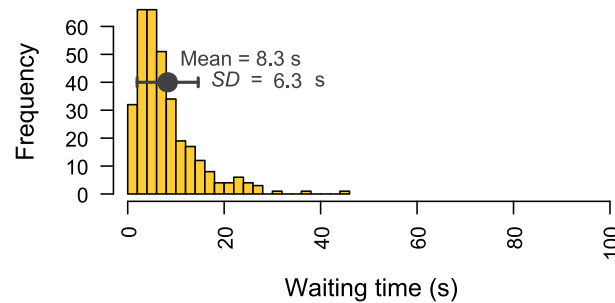


Stated factors that would increase chances of actuation in Group B (n = 58)

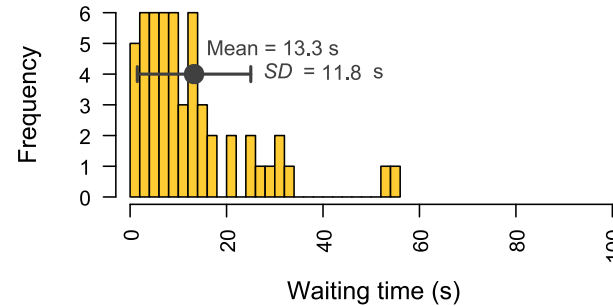
Why actuation is more likely at RRFBs compared to PHBs?

One possible explanation...

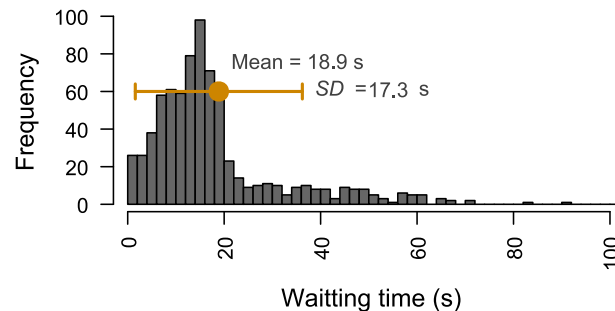
(a) RRFB actuation



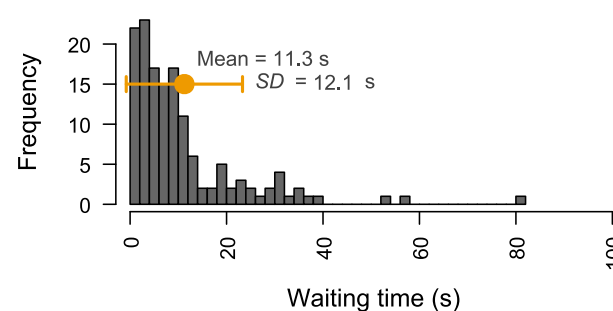
(b) RRFB no actuation



(c) PHB actuation



(d) PHB no actuation



Differences by device and actuation status persist after accounting for speed limit, location, direction of travel, time of day, day of week, pedestrians in queue, and number of vehicles observed.

Median waiting time 52.0% shorter for an actuated RRFB compared with an actuated PHB under the same crossing conditions

Takeaways...



Key findings and recommendations

- ▶ Adverse crossing conditions (e.g., heavy traffic, higher speeds, and longer distances) motivate pedestrians to actuate PHBs and RRFBs

Installations under such conditions are more likely to have higher actuation rates

- ▶ Pedestrians are more than twice as likely to actuate RRFBs than PHBs

One likely reason is longer waiting times at PHBs

PHBs should be preferred at more challenging crossings (where pedestrians are more likely to tolerate longer waits)

More research needed on ways to reduce waiting times at PHBs

Key findings and recommendations (continued)

- ▶ Site design matters: pedestrian refuges, medians, and other design elements (i.e., sidewalks on both sides) improve the odds of actuation and yielding, and reduce the odds of pedestrians crossing outside the crosswalk
- ▶ Both PHBs and RRFBs are recommended for midblock locations and discouraged within 200 ft of intersections
- ▶ We did not find evidence of pedestrian confusion about how the devices work and how to operate them

The Insurance Institute for Highway Safety (IIHS) is an independent, nonprofit scientific and educational organization dedicated to reducing deaths, injuries and property damage from motor vehicle crashes through research and evaluation and through education of consumers, policymakers and safety professionals.

The Highway Loss Data Institute (HLDI) shares and supports this mission through scientific studies of insurance data representing the human and economic losses resulting from the ownership and operation of different types of vehicles and by publishing insurance loss results by vehicle make and model.

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Study sponsored by
Center for Transportation
Safety

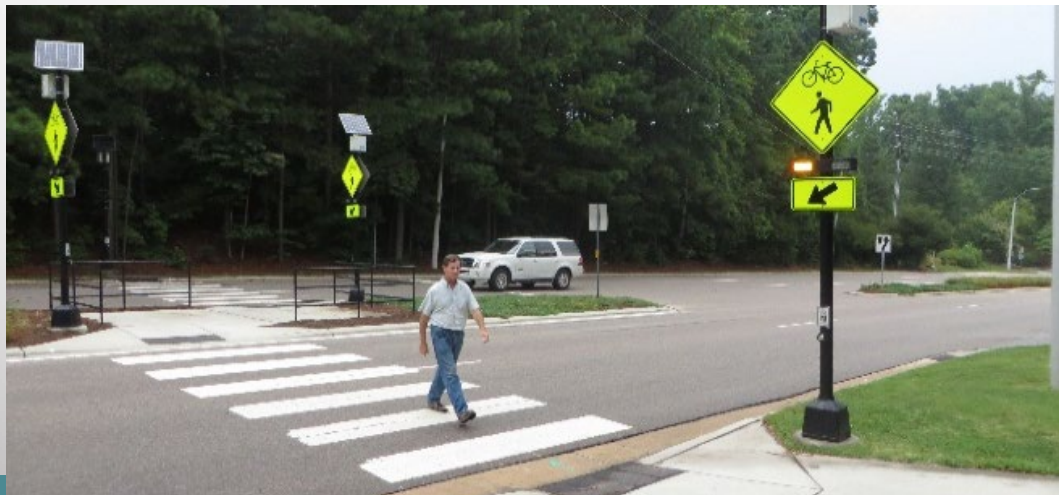
Texas A&M
Transportation Institute

Comparison of Driver Yielding and Crashes for Texas Sites

Boni Kutela
Kay Fitzpatrick
David Florence

Background

- More types of pedestrian traffic control devices (TCDs) have been developed and installed at pedestrian crossings



Background

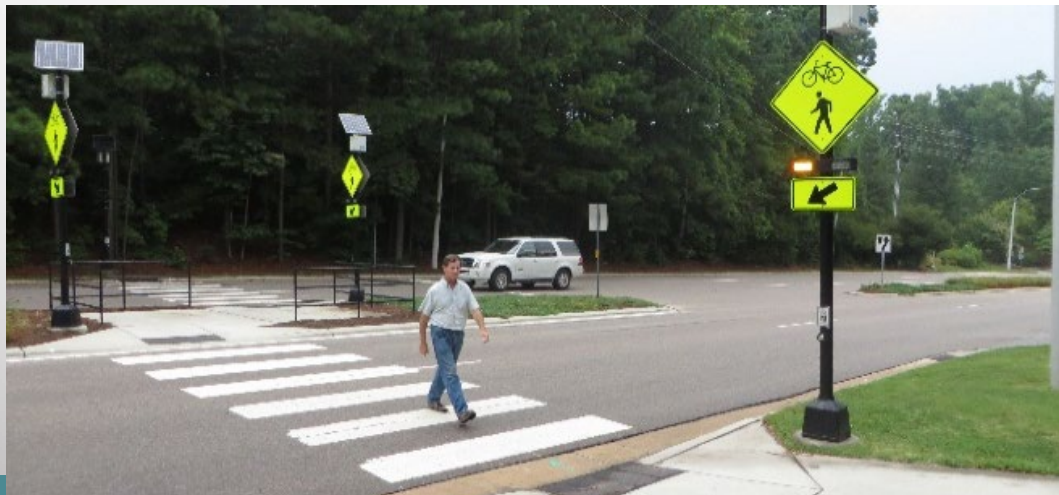
- Crashes are the preferred metric when evaluating safety effectiveness of treatment
- Because of the novelty of these recently developed pedestrian TCDs and infrequency of crossing crashes, a different safety surrogate was developed – driver yielding

Background

- Driver yielding is the percent of drivers who yield to a crossing pedestrian.
- Driver yielding can consider all pedestrians but frequently focuses on staged pedestrians to collect sufficient data in a reasonable data-collection period.
- Staged pedestrian (consistent pedestrian behavior) involves the following steps
 - Approach the crossing when a vehicle is oncoming (staged pedestrian).
 - Activate the RRFB device (staged pedestrian).
 - Place a foot on the pavement and comply with State laws (staged pedestrian).
 - Record the number of drivers who did not and did yield (staged pedestrian partner).
 - Count the number of vehicles and pedestrians just before crossing (from video).

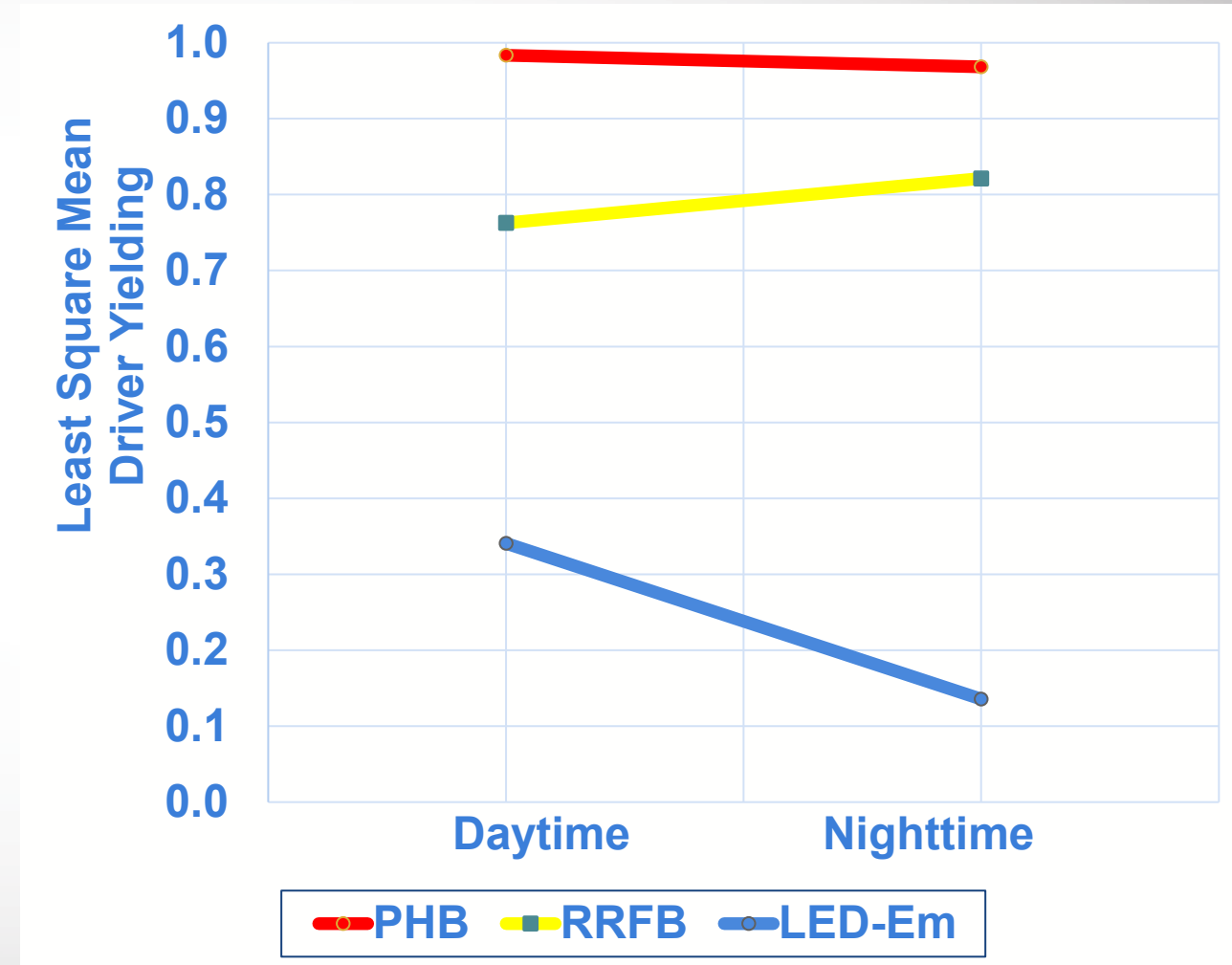
Project Goal

- How well do driver yielding results compare to the crash experience for the following three types of pedestrian TCDs:
 - PHB
 - RRFB
 - LED-Em



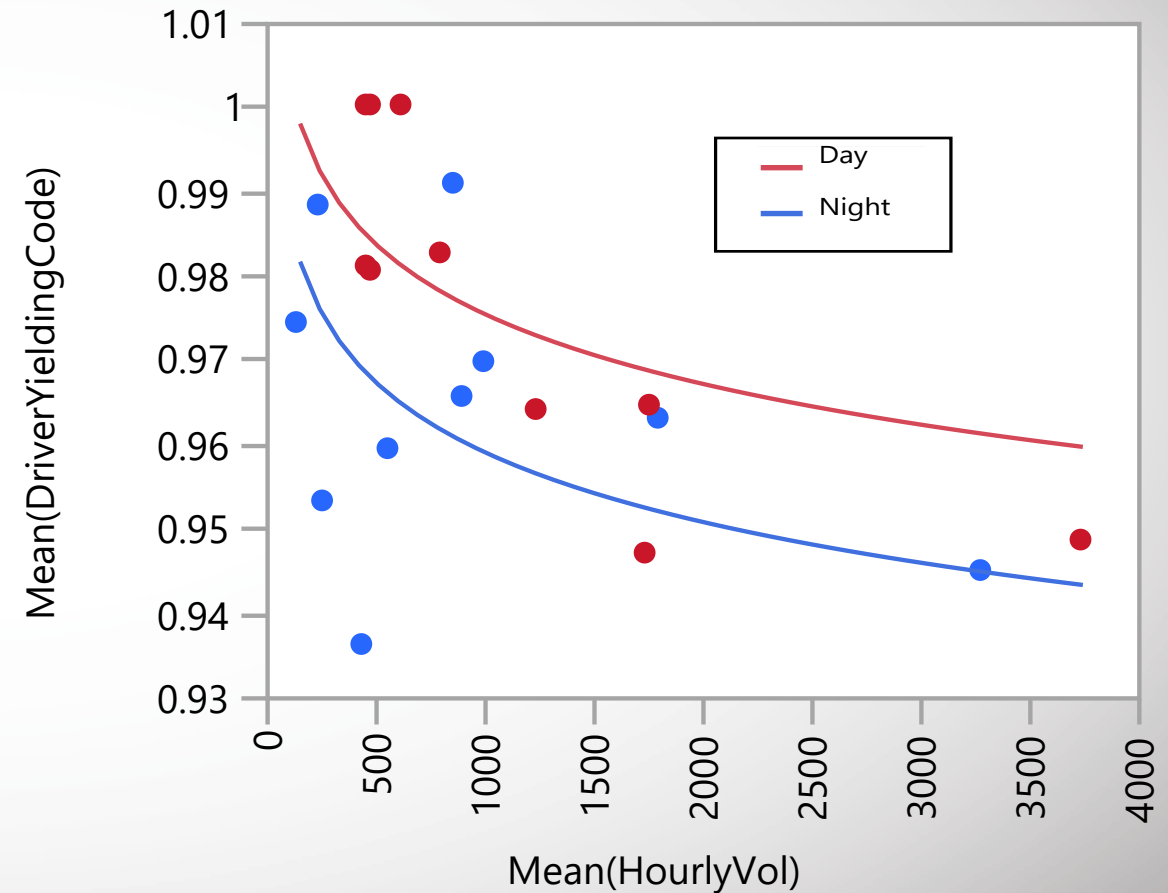
Previous Texas Studies

- Utilized previous Texas studies
 - Consider all data
 - Treatment type (results are different, statistically)
 - PHB = similar day & night
 - RRFB = higher at night (not statistically significant)
 - LED-Em = higher at day (statistically significant)



Previous Texas Studies (PHB)

- PHB
 - Data for 10 PHB sites
 - Significant variables:
 - Light level
 - Higher driver yielding during daytime (98% compared to 96%), but not practically different
 - Hourly volume
 - Slightly lower driver yielding at higher volumes, again not practically different



Previous Texas Studies (RRFB)

- RRFB
 - The study included data for 12 RRFB sites
 - Limited additional insights,
 - Demonstrates that site conditions greatly influence driver yielding for this type of device
 - Support the use of advance yield lines



Previous Texas Studies (LED-Ems)

- LED-Ems
 - Number of sites: 13 daytime, 6 nighttime
 - Findings, higher driver yielding for:
 - Lower speed limit group (20-school zone, 30-35 mph)
 - 2 lanes rather than 4 lanes
 - Narrow lanes (10.5-11 ft rather 11.5-12 ft)
 - Lower hourly volumes
 - Daytime
 - Advance yield line present



Project Approach

- During this effort, tried to add RRFB and LED-EMs sites
 - No new sites with LED-EMs were identified
 - Identified eight new RRFB sites
 - Collected driver yielding data at the RRFBs



Project Approach

- Explore the relationship between crashes and yielding rates
 - Seven years of crash data (2017-2023)
 - Identified crashes within 150 ft buffer of crossing

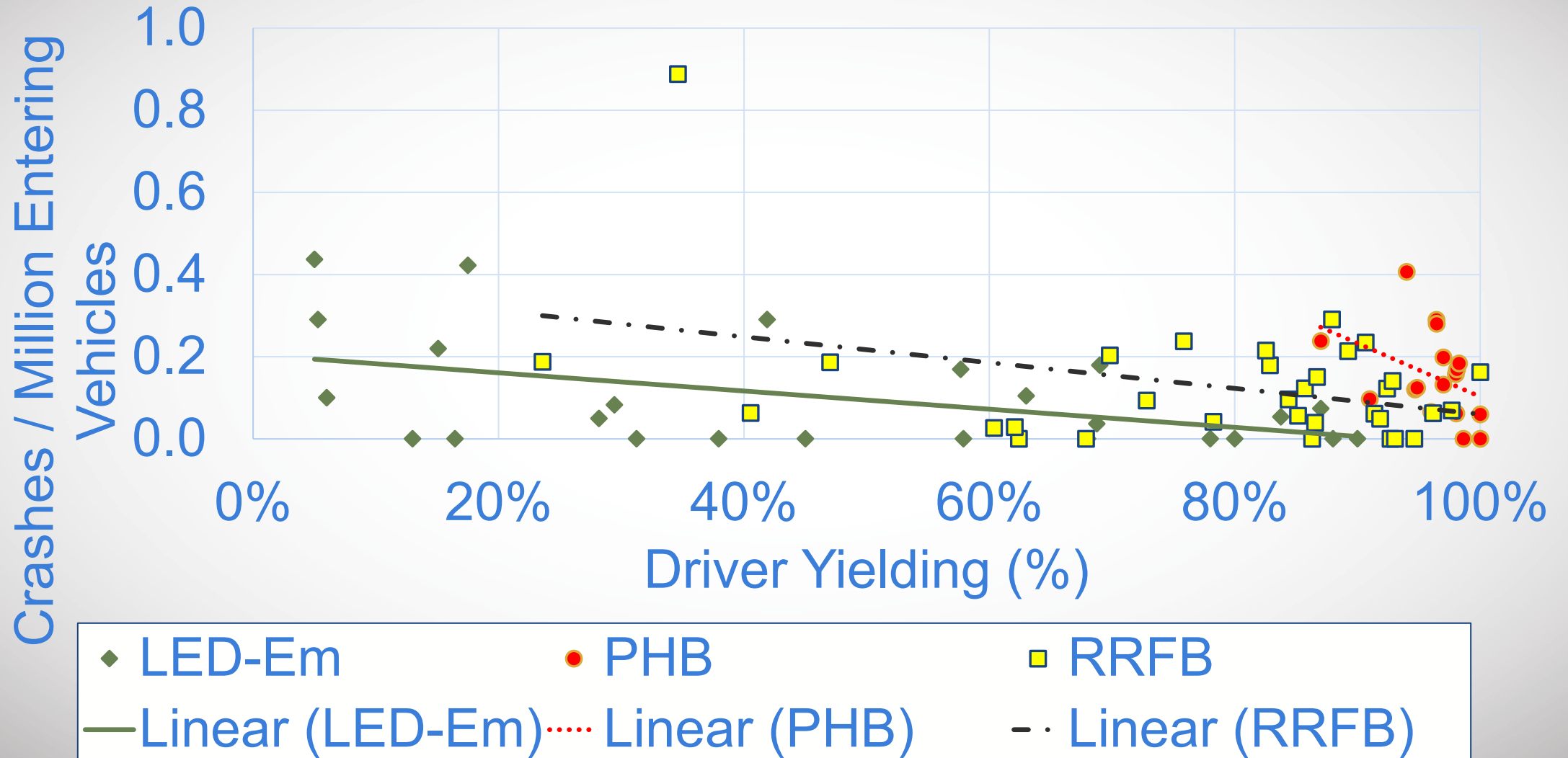


- Regression analysis for the relationship between crash rates and yielding

Descriptive Statistics

Treatment type	Number of sites	Posted speed limit group	Main Street Through lanes per direction	Average crashes	Average yielding rate	Average AADT (vpd)	Average years of crash data (years)	Average crash rate
PHB	14	30-35	1	3.50	0.98	10960	6.73	0.09
			2	10.80	0.95	22620	6.87	0.18
	3	40-50	2	2.67	0.99	7400	6.63	0.14
LED-Em	20	30-35	1	0.64	0.65	6440	4.28	0.07
			2	3.33	0.45	11030	5.52	0.10
	5	40-50	1	4.00	0.15	6130	7.00	0.22
			2	1.50	0.10	12360	3.23	0.13
RRFB	14	30-35	1	4.00	0.68	4620	7.00	0.29
			2	3.00	0.84	16430	7.00	0.07
			3	21.00	0.88	27740	7.00	0.29
	19	40-50	2	3.36	0.83	13280	6.04	0.11
			3	4.80	0.65	30330	5.12	0.09
All	75	All	All	4.17	0.72	13840	5.87	0.12

Results – Plot



Results – Models

Parameter	Estimate	Std Error	t-statistic	P-value
Intercept	1.5196	0.7427	2.046	0.0587
Driver Yielding (PHBs)	-1.4219	0.7718	-1.842	0.0853

Note: Adjusted R-squared: 0.1301, F-statistic: 3.394 on 1 and 15 DF, p-value: 0.0853, N = 17

Parameter	Estimate	Std Error	t-statistic	P-value
Intercept	0.3730	0.1134	3.289	0.0025
Driver Yielding (RRFBs)	-0.3114	0.1406	-2.215	0.0342

Note: Adjusted R-squared: 0.1088. F-statistic: 4.906 on 1 and 31 DF, p-value: 0.03425, N = 33

Parameter	Estimate	Std Error	t-statistic	P-value
Intercept	0.20416	0.04648	4.392	0.0002
Driver Yielding (LED-Ems)	-0.21940	0.08393	-2.614	0.0155

Note: Adjusted R-squared: 0.1955. F-statistic: 6.833 on 1 and 23 DF, p-value: 0.01551, N = 25

Conclusions

- Overall, an increase in driver yielding is associated with a decrease in the number of crashes
- The magnitude of effect varies by traffic control device (highest at the PHB and lowest at LED-Ems)

Future Research Needs

- Current study has a limited number of sites
- Current study was not able to account for site variations that could also be influencing crashes (e.g., number of legs, etc.)
- Future study should:
 - Focus on one of the traffic control devices (e.g., PHB or RRFB)
 - Identify other variables that could influence crash prediction for the treatment (e.g., number of lanes, presence of median, etc.)
 - Collect data at sites with the range of variables of interest