Analyzing Speed Choice Near Pedestrian Crossing Treatments

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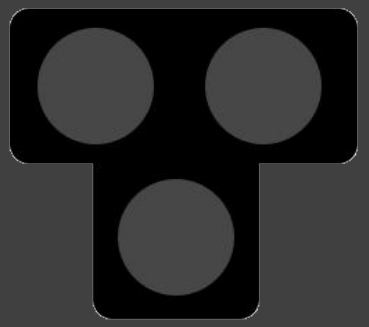
Introduction

- According to the National Highway Traffic Safety Administration (NHTSA), nearly 26% (9,478) of all traffic fatalities in 2019 were related to speeding.
- Speeding can create hazards for passengers, other drivers, and nearby vulnerable road users.
- Besides the hazards that speeding causes, speeding can also limit the effectiveness of various traffic safety programs that are implemented to reduce the other traffic safety risks and pedestrian safety initiatives.
- Pedestrian crossing treatments (PHB or RRFB) may affect driving behavior upstream and downstream of the treatment, which can be understood with a driving simulator.
- In this study, a comparative driving behavior assessment method is proposed to analyze the effects of pedestrian crossing treatments (RRFB and PHB) on drivers' speeding behavior.

Pedestrian Hybrid Beacon (PHB)



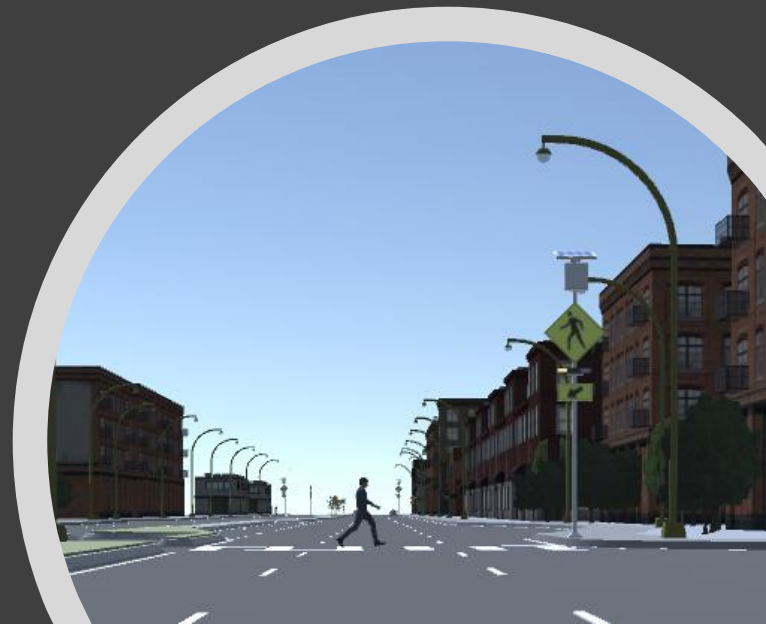
Rectangular Rapid Flashing Beacon (RRFB)

Driving Simulator

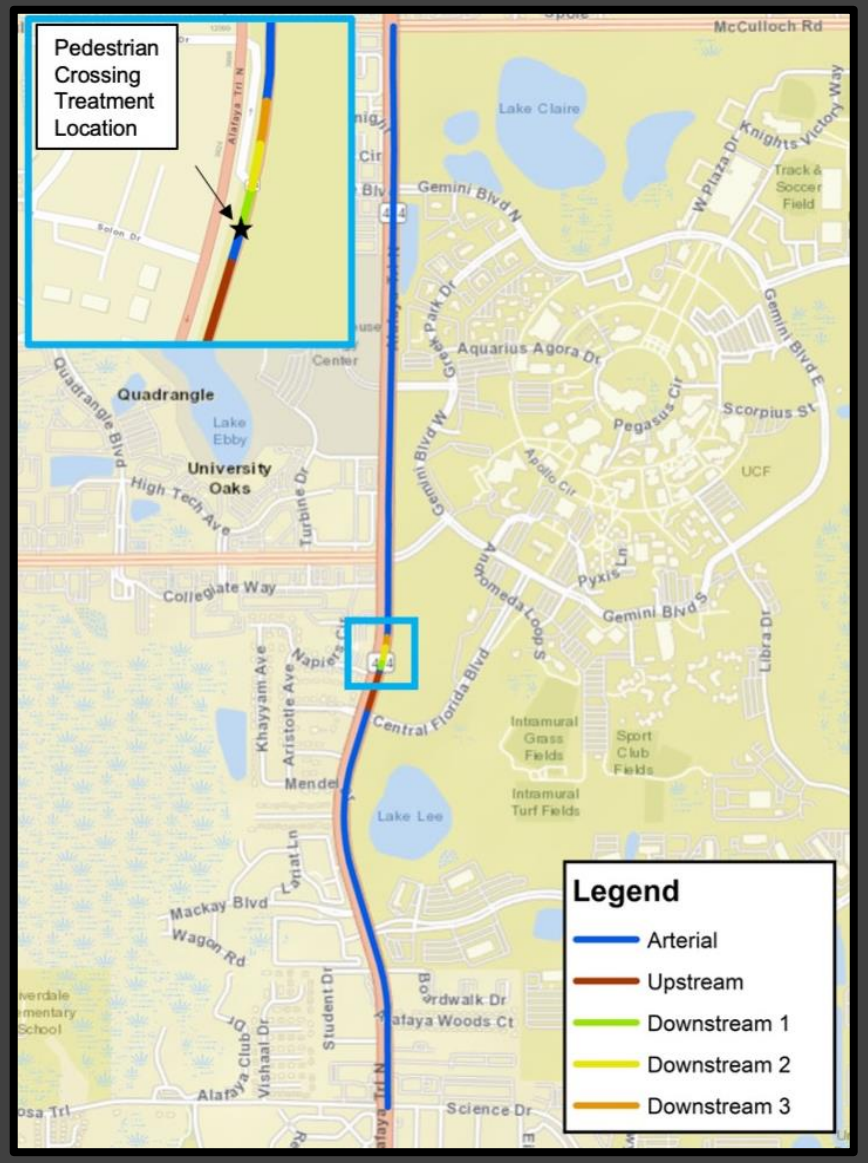
- The Smart and Safe Transportation Lab developed at the University of Central Florida (UCF) located in Orlando, FL was used to conduct the driving simulator experiment and collect the data.
- The simulator has three screens (20.5 in. high and 27.9 in. wide) with a 135 degrees front field of view and left, middle, and right rear-view mirror.
- The lab has three driving simulators which can be used simultaneously to conduct a multi-driving simulator study. For the purposes of this analysis only one simulator was used.

Experiment Design

- The experiment was a within-subjects experiment. The scenario type (e.g., without/with pedestrian crossing treatments) were within variables, and each participant driver experienced randomly a scenario under both conditions of with a pedestrian crossing treatment (RRFB and PHB) and a base condition.
- The scenarios were modeled after two roads in the Central Florida region.



Alafaya Trail

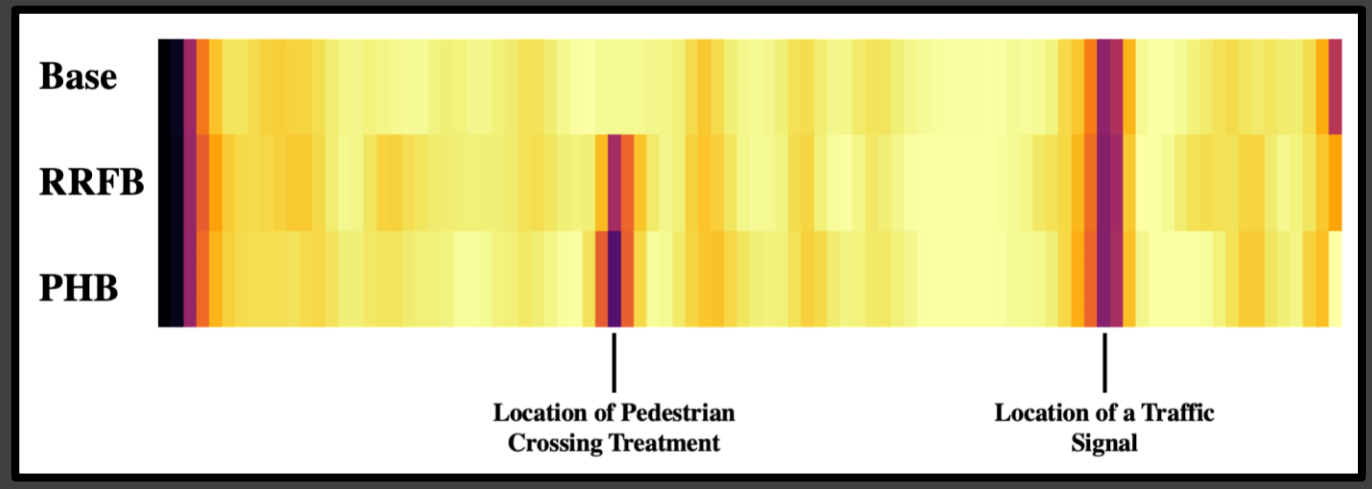


Orange Blossom Trail

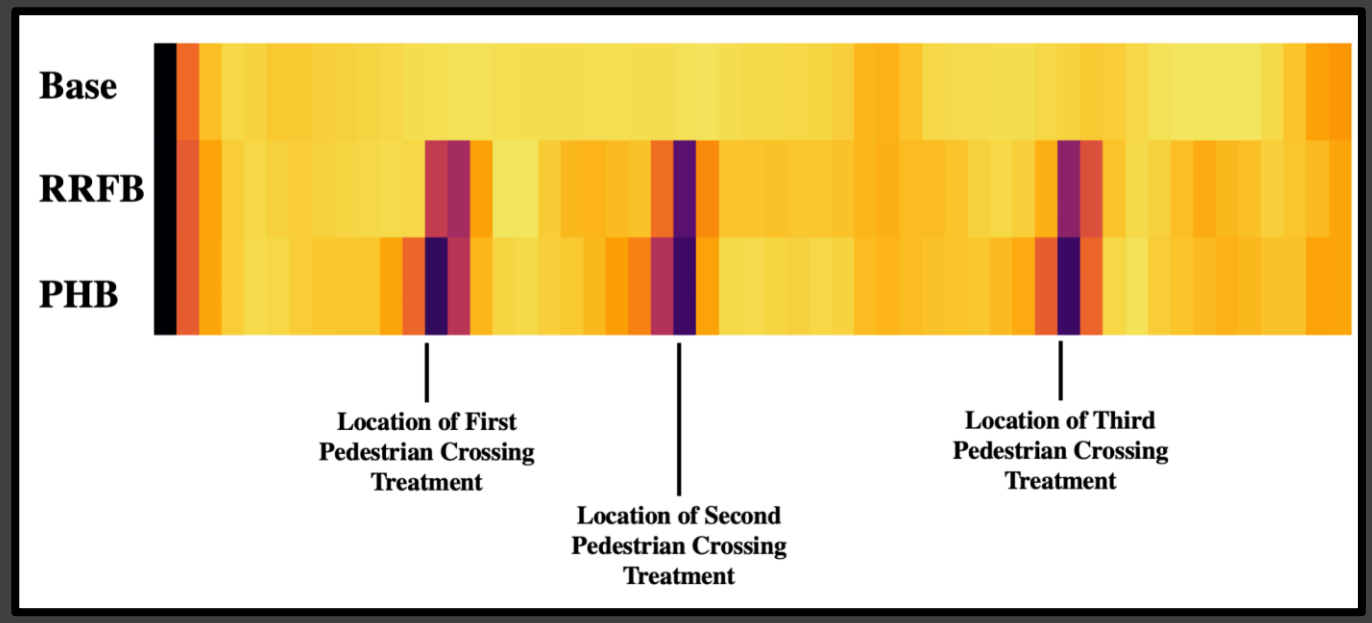
Descriptive Statistics

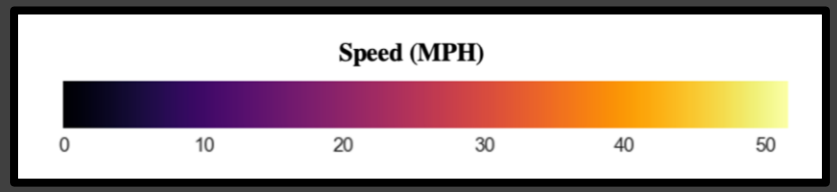
Name	Description	Input value	Count
Scenario Related Variables			
PCT_TYPE	Pedestrian crossing treatment type	PHB=1 RRFB = 0	576 576
ROAD	Roadway	N Alafaya Trail = 1 S Orange Blossom Trail = 0	288 864
LOCATION	Location of the analysis zone	Upstream = 1, Downstream = 0	576 576
FIRST_TREATMENT	Position of the pedestrian crossing treatment is first	Yes = 1 No = 0	576 576
Participant Related Variables			
GENDER	Gender	Male = 1 Female = 0	18 18
EDU	Education levels	Bachelor's Degree = 1 Other = 0	10 26
YOUNG	Young participants (age between 18 and 24)	Yes = 1 No = 0	10 26
OLD	Old participants (age > 40)	Yes = 1 No = 0	13 23
LANE_MIDDLE	Whether the preferred driving lane is the middle lane	Yes = 1 No = 0	19 17
LANE_LEFT	Whether the preferred driving lane is the left lane	Yes = 1 No = 0	12 24

Alafaya Trail



Orange Blossom Trail





Speed Adjustment Indexes

- The proportion of average speed reduction is calculated as follows:

$$Proportion_{reduction} = \frac{v_{Base} - v_{PCT}}{v_{Base}}$$

- where, v_{PCT} is the average speed for the pedestrian crossing treatment scenario (RRFB and PHB) and v_{Base} is the average speed for the base scenario.

- Sometimes drivers may not reduce speed in the pedestrian crossing treatment scenario (i.e., failed to comply with the pedestrian crossing treatment) and may instead increase or keep their speed instead. In that case, the $Proportion_{reduction}$ can be a negative or a zero value. Meanwhile, the positive proportion of average speed reduction should be on the interval (0,1), given the nature of the proportion variable.

Logistic Regression

	Grouped Random Effect Hurdle Beta Regression Model				Fixed Effect Hurdle Beta Regression Model			
Logistic Regression	Mean	S.E.	10%	90%	Mean	S.E.	10%	90%
Constant	0.5257**	0.3073	0.1367	0.9797	0.4725**	0.2695	0.1046	0.7969
Scenario Related Variables								
PCT_TYPE (PHB=1, RRFB = 0)	0.2306*	0.1491	0.02836	0.4094	0.2186*	0.1448	0.0355	0.4052
ROAD (Alafaya = 1, US441 = 0)	0.2845*	0.1848	0.06102	0.5104	0.3036**	0.185	0.07397	0.5536
LOCATION (Upstream = 1, Downstream = 0)	1.206**	0.1583	1.002	1.405	1.207**	0.1577	1.003	1.412
Participant Related Variables								
GENDER (M = 1, F = 0)	0.4052**	0.1659	0.2002	0.6166	0.4007**	0.1561	0.2156	0.6055
EDU (Bachelor's Degree = 1, Other = 0)	-0.6106**	0.1851	-0.8352	-0.3628	-0.6099**	0.1825	-0.8499	-0.3805
LANE_MIDDLE (Yes = 1, No = 0)	-0.728**	0.1812	-0.9467	-0.4842	-0.7372**	0.1755	-0.9729	-0.5121
ACC (90th Percentile of Acceleration)	0.07583**	0.04261	0.01613	0.1311	0.08553**	0.03621	0.0373	0.1333
DIC	458.788				465.186			

*
Significant at the 90% confidence level.

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Significant at the 95% confidence level.

Beta Regression

	Grouped Random Effect Hurdle Beta Regression Model				Fixed Effect Hurdle Beta Regression Model			
Beta Regression	Mean	S.E.	10%	90%	Mean	S.E.	10%	90%
Constant	-1.756**	0.1278	-1.916	-1.576	-1.716**	0.1188	-1.868	-1.557
Scenario Related Variables								
PCT_TYPE (PHB=1, RRFB = 0)	0.3555**	0.05952	0.2825	0.4384	0.357**	0.05814	0.2822	0.4305
ROAD (Alafaya = 1, US441 = 0)	0.4094**	0.09664	0.2847	0.5323	0.3966**	0.09785	0.263	0.5149
LOCATION (Upstream = 1, Downstream = 0)	1.256**	0.06783	1.172	1.343	1.249**	0.06168	1.168	1.329
FIRST_ TREATMENT (Yes = 1, No = 0)	-0.4932**	0.07998	-0.5923	-0.3816	-0.4932**	0.07344	-0.5838	-0.3911
Participant Related Variables								
LANE_LEFT (Yes = 1, No = 0)	0.2591**	0.06308	0.1805	0.3431	0.2577**	0.06141	0.1799	0.3384
ACC (90th Percentile of Acceleration)	0.0376**	0.01665	0.01483	0.05746	0.03296**	0.01633	0.01147	0.05332
DIC	458.788				465.186			

*
Significant at the 90% confidence level.

**
Significant at the 95% confidence level.

Conclusions

- The study found that while both the RRFB and PHB are able to have an effect in speed reduction on arterials beyond the location of the pedestrian crossing treatments. Drivers reduce the speed greater with the activation of the PHB, in comparison with the RRFB.
- The first pedestrian crossing treatment that was experienced by the driver showed to have a less of a speed reduction when compared to the second or third pedestrian crossing treatments. Furthermore, in agreement with the findings of previous studies, drivers will tend to have a greater speed reduction as they become more familiar with the operations of the pedestrian crossing treatments.
- With a better understanding of drivers' speed adjustments responding to the pedestrian crossing treatments, appropriate pedestrian crossing treatments can be suggested to enhance pedestrian safety and reduce speeding on arterials.
- It is important to note that speed reduction on the arterials were obtain when the pedestrian crossing treatments were activated, therefore if speeding occurs during a period with not a high number of pedestrians using the pedestrian crossing treatments, the pedestrian crossing treatment might have less of an effect on speed reduction.

Thank you!