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PET shopping: Arbitrary selection of post-encroachment time thresholds for right-angle bicyclist-vehicle conflicts

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Introduction

Signalised intersections and high crash frequencies appear to go hand in hand. To an extent this can be expected: traffic signals are typically implemented at intersections with high traffic volumes and where different road users mix and perform different movements, factors known to increase crash likelihood. The overarching aim of the present study is to gain insight in the effects of infrastructure design elements on safety of signalised intersections in the Netherlands. Focussing on right-angle conflicts between bicyclists and motorized vehicles, this study sought to explore the effects of signal phase (e.g., bicyclist and motorized vehicles have a 'shared' green phase vs. a 'separate' green phase) and crossing length on traffic safety.

A common methodology to observe and study conflicts as a surrogate measure of safety is by site-based camera observation, where conflicts are identified based on relatively short time-gaps between the crossing trajectories of a bicyclist and a vehicle, a.k.a. a low post-encroachment time (PET). PET thresholds to identify conflicts on signalized intersections vary in literature, with examples ranging from less than 1s to more than 5s. Notably, studies investigating bicyclist-vehicle conflicts have used PET thresholds which were calibrated on vehicle-vehicle crash data. This raises the question: how does arbitrary selection of a PET threshold affect the findings of subsequent analysis? The present study explores the sensitivity of statistical models by manipulating the PET threshold with which conflicts are identified.

Research methodology

A site-based camera observation study was performed on 16 approaches at 9 intersections in 5 Dutch cities. Approaches were selected by the corresponding cities based on high bicyclist volumes. Data at each approach were collected over 7 full days (168h). The pre-processing of video data was conducted by Transoft Solutions, Inc, resulting in two tables for each approach: a count table with dates and timestamps of individual road users (including road user ID, type, and direction), and a conflict table for PET values up to 10s (same information per conflict partner, and conflict speed and arrival order). An R-script selected right-turning motorized vehicles and bicyclists going straight. Quarterly-hour volumes and conflict counts were calculated for each approach. The PET threshold was manipulated between 0.5s and 5.0s at increments of 0.1s. For each PET threshold, six Generalized Linear Mixed Models predicting conflict count were tested, with approach as random effect, and the following predictors: 1) an intercept model, 2) bicyclist and vehicle volumes, 3) volumes and signal phase, 4) volumes and crossing length (in m), 5) volumes, signal phase, and crossing length (main effects only), and 6) volumes with signal phase X crossing length (main effects and interaction). The model with the best fit was chosen in subsequent analyses.

Results

Between 334 and 35830 conflicts were found using the PET threshold range between 0.5s to 5.0s. Model 5 showed the best fit on the data. Bicycle and motor vehicle volume were significant for all PET thresholds; whereas signal phase and crossing length were significant for PET > 0.5s and PET < 1.0s, respectively. None of the predictors flipped sign throughout the PET threshold range, but their magnitude varied (see Figure 1a). For signal phase, shared green was associated with a higher conflict count than separate green, with the regression coefficient ranging between 0.87 and 1.38. A 'dip' around 1.0s is observed for the regression coefficient of signal phase. Splitting the conflicts based on arrival order indicates that conflicts in which the bicyclist arrived first (Figure 1b) are responsible for this dip. Conflicts in which the vehicle arrived first (Figure 1c) show a continuous decrease of the regression coefficient for signal phase with increasing PET thresholds, steepest between 0.8s and 1.2s.

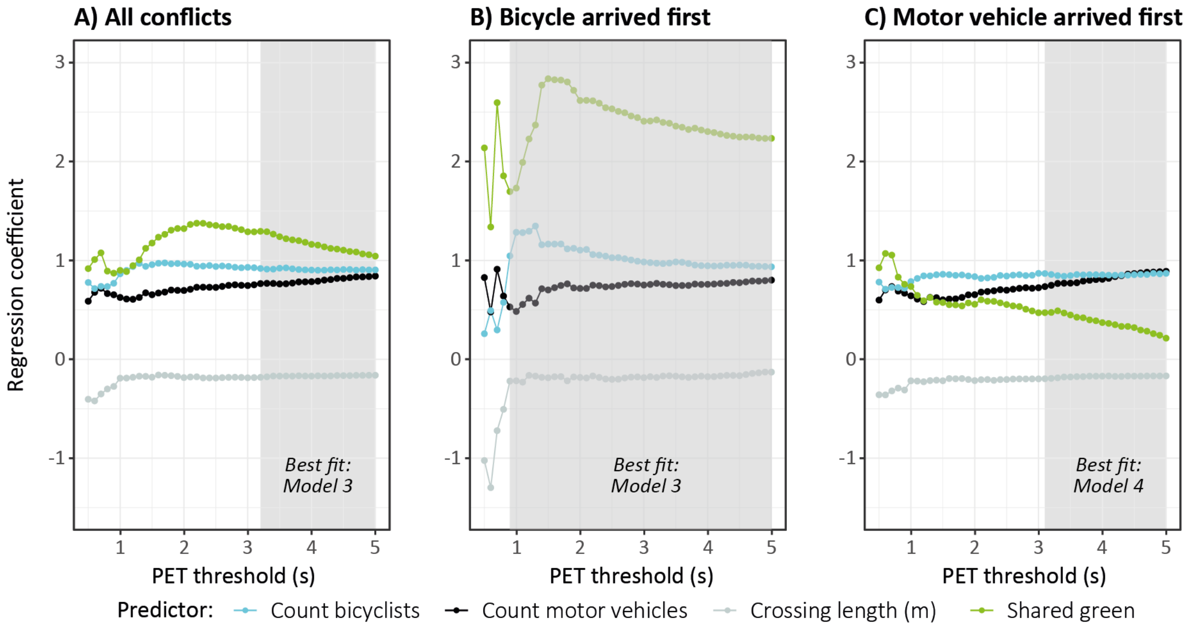

Figure 1. Effect of PET threshold on regression coefficients in Model 5 (represented by dots), involving all conflicts (panel A), or separating the data based on arrival order in the conflict (panels B,C). Gray areas indicate PET thresholds at which other models showed a better fit.

Discussion & conclusion

The results show that a shared green signal phase is associated with significantly more bicyclist-vehicle conflicts than a separate green signal phase. The magnitude of this effect varies strongly based on which PET threshold is chosen. Such variation may influence policy makers in how they choose to implement signals at an intersection. This stresses the importance of selecting a PET threshold calibrated on actual bicyclist-vehicle crashes. The results further suggest that differences exist between conflicts where bicyclists arrive first, and conflicts where vehicles arrive first. Finally, patterns arising from the strong differences in regression coefficients as function of PET thresholds suggest that different conflict (and supposedly crash) mechanisms are in play (for different ranges in the PET thresholds). Follow-up research on reasons for this apparent difference is warranted.