Event-Based Modeling of Driver Yielding Behavior to Pedestrians at Two-Lane Roundabout Approaches

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Background

• Roundabouts
  – Safety and operational benefits for vehicles
  – Increasing trend in building multi-lane roundabouts

• Pedestrians at Roundabouts
  – Accessibility issues
  – Crossing is not signalized
  – Motorists fail to yield to pedestrians
Objective and Motivation

• Objective:
  – Understanding driver decision of yielding to pedestrians
    • Contributing factors that increase probability of driver yielding
  – Controlling for pedestrian behavior
    • Staged pedestrian crossing

• Application:
  – Regression models to be implemented in Simulation for Pedestrian-vehicle interaction at unsignalized crossings
  – Roundabout traffic dynamics and design
  – Site specific factors
Study Locations

- Raleigh, NC
- Carmel, IN
- Nashville, TN
- Annapolis, MD
- Towson, MD
- Winston-Salem, NC
Equipment Set up and Data Collection

Observing driver yielding to staged pedestrians

Data Collection Sheet
Data Collection Protocol

• Microscopic traffic characteristics:
  – Interaction of first arriving vehicle with pedestrian:
    • Speed (SPD), lane location (FAR), in platoon (PLT), if already stopped (STP), other pedestrians present (MUP), heavy vehicle (HGV), right-turning vehicle (RT, for Exit), downstream conflict (DSC, for Entry)
  – Pedestrian Behavior
    • Blind or sighted (CN), pedestrian location: at the curb or in the crosswalk (FT)
  – Response Variable:
    • If first vehicle yielded (YIELD)
Model Development

- Probability of driver yielding to pedestrians (Schroeder, Rouphail, 2011): Binary logistic regression model

\[
\text{Logit} \left[ P(Y = 1) \right] = \log\left( \frac{P(Y = 1)}{1 - P(Y = 1)} \right) = \beta_0 + \sum_{i=1}^{m} \beta_i x_i
\]

- \( Y \): Driver Yielding (Binary outcome)
- \( P(Y=1) \): Probability of driver yielding
- \( \beta_0 \): Intercept
- \( \beta_i \): Parameter describing the effects of \( m \) explanatory variables \( x_i \) on the yield response
Results: Regression Models

- Significant Factors
  - Entry vs. Exit,
  - Speed,
  - Lane location,
  - White Cane,
  - Site specific characteristics

<table>
<thead>
<tr>
<th></th>
<th>P(Yield)-All</th>
<th>P(Yield)-Entry</th>
<th>P(Yield)-Exit</th>
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<tbody>
<tr>
<td></td>
<td>Estimate</td>
<td>Odds Ratio</td>
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<tr>
<td>Intercept</td>
<td>1.74</td>
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<td>2.00</td>
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<tr>
<td>DSC</td>
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<tr>
<td>SPD</td>
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<td>0.91</td>
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<tr>
<td>FAR</td>
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<td>RT</td>
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<td>PLT</td>
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<tr>
<td>MUP</td>
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<tr>
<td>CN</td>
<td>1.41</td>
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<tr>
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<td>0.457</td>
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*p<0.001  b p<0.05

Speed: Entry: OR=0.91, Exit: OR=0.73
White Cane: Entry: OR=5.06, Exit: OR=3.74
Results: Regression Models

- \( P(\text{Yield}) = 0.55 \)
- \( P(\text{Yield}) = 0.25 \)
- \( P(\text{Yield}) = 0.20 \)
- \( P(\text{Yield}) = 0.10 \)
Effect of Site Specific Characteristics

- ANN: $P(\text{Yield}) = 0.80$
- IN, NASH, TSN: $P(\text{Yield}) = 0.50$
- RAL: $P(\text{Yield}) = 0.20$
- SLM: $P(\text{Yield}) = 0.10$
- TSN: $P(\text{Yield}) = 0.25$
- ANN: $P(\text{Yield}) = 0.10$
- IND, NASH, SLM, RAL: $P(\text{Yield}) = 0$
Conclusion

• The probability of yielding decreases as speed increases
• Yielding rates at the entry are generally higher compared to exit
• Drivers have higher yielding rates to pedestrian carrying a white cane
• Site specific characteristics are significant in modeling the propensity of driver yielding to pedestrians