Evaluation of Bicyclist Physiological Response and Visual Attention in Commercial Vehicle Loading Zones

Authors:
Hisham Jashami, PhD, Research Assistant Professor
Douglas Cobb, PhD, Traffic Engineer
Ivan Sinkus, Undergraduate Research Assistant
Yujun Liu, Graduate Assistant
David Hurwitz, Ph.D., Professor

6/7/2022
Research Background

- With pressure from multiple modes for curb capacity, cities are considering the allocation of curb space
- Rapid growth in urban freight deliveries (e-commerce)
- Safety - drivers killed and injured making deliveries
- Existing road infrastructure does not accommodate needs of a delivery truck - ad hoc solutions prevail so drivers often block roadways and paths
Research Background

- Needs of a delivery trucks are not acknowledged in roadway design and standards guides
- Significant gaps concerning freight in street design prescriptions such as Complete Streets and Smart Growth
- Commercial vehicles using loading zones are often not provided with usable or consistent envelope adjacent to the vehicle for loading and unloading activities.
Research Goals

- Explore where commercial vehicle activity disrupts bicyclists
- Support better roadway and loading zone design guidelines

Research Questions

- **R1**: How is the cyclist’s Galvanic Skin Response (GSR) readings influenced by the size of the loading zone, and the presence of the courier or hand cart?
- **R2**: Is the visual attention of a cyclist influenced by the loading and unloading activities around the commercial vehicle?
OSU Bicycling Simulator

Right: Eye tracker laptop;  
Middle: Bicycle simulator workstation;  
Left: iMotions laptop

Participant view on a simulator

Researcher testing a scenario
<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>Level</th>
<th>LEVEL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement Marking</td>
<td>0</td>
<td>No CVLZ – Truck in Bike Lane</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Min CVLZ – Size of the vehicle only</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Max CVLZ – Size of the vehicle plus desired operational footprint (total width = 4.50 m)</td>
</tr>
<tr>
<td>Courier Position</td>
<td>0</td>
<td>No Courier</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Courier Behind Vehicle</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Courier on Driver’s Side</td>
</tr>
<tr>
<td>Accessory</td>
<td>0</td>
<td>No Accessory</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Hand Truck</td>
</tr>
</tbody>
</table>
Simulated Roadway Geometry

1 meter = 3.28 feet
Example Scenarios
Example Sequence of Scenarios
Experiment Protocol

- Recruitment
- Consent
- Pre-Screening
- Calibration
- Eye Tracking
- Experimental Ride
- Survey
Experiment – Data Acquisition

Participants:
- 50 Participated
- 1 Simulator Sickness
- 1 calibration issue
- 48 Usable
- 864 scenarios
- 25 male, 25 female
- Age range 18-74 years
- Mean age: 32.94 years & SD = 11.52

Data:
- GSR
- Visual attention
- Pre-post Survey
## Pre-Survey

<table>
<thead>
<tr>
<th>Bicycling Habit</th>
<th>Possible Responses</th>
<th>Number of Participants</th>
<th>Percentage OF Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicycling Mileage Per Week</td>
<td>Never</td>
<td>6</td>
<td>12.0%</td>
</tr>
<tr>
<td></td>
<td>Less than 1 mile</td>
<td>7</td>
<td>14.0%</td>
</tr>
<tr>
<td></td>
<td>1-5 miles</td>
<td>11</td>
<td>22.0%</td>
</tr>
<tr>
<td></td>
<td>5-10 miles</td>
<td>11</td>
<td>22.0%</td>
</tr>
<tr>
<td></td>
<td>10-20 miles</td>
<td>8</td>
<td>16.0%</td>
</tr>
<tr>
<td></td>
<td>20-50 miles</td>
<td>6</td>
<td>12.0%</td>
</tr>
<tr>
<td></td>
<td>50+ miles</td>
<td>1</td>
<td>2.0%</td>
</tr>
<tr>
<td>Type of Cyclist</td>
<td>Strong and Fearless</td>
<td>5</td>
<td>10.0%</td>
</tr>
<tr>
<td></td>
<td>Enthused and Confident</td>
<td>34</td>
<td>68.0%</td>
</tr>
<tr>
<td></td>
<td>Interested but Concerned</td>
<td>11</td>
<td>22.0%</td>
</tr>
<tr>
<td></td>
<td>No Way No How</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>Riding Purpose</td>
<td>Commuting to work/school</td>
<td>30</td>
<td>30.6%</td>
</tr>
<tr>
<td></td>
<td>Recreation</td>
<td>34</td>
<td>34.7%</td>
</tr>
<tr>
<td></td>
<td>Exercise</td>
<td>33</td>
<td>33.7%</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>1</td>
<td>1.0%</td>
</tr>
</tbody>
</table>
Data Collection (SimObserver)
Data Collection (iMotions)

- GSR (Galvanic Skin Response)
- Shimmer3 GSR + sensor
- Output: peaks/min
Results (GSR)

- GSR Reading
- Two-way interactions of all possible variables
Results (Post Survey VS GSR)

- Validating GSR

"In which scenario did you feel most comfortable?"

<table>
<thead>
<tr>
<th>Participant Answer</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>The commercial vehicle in the bike lane (no loading zone)</td>
<td>1</td>
</tr>
<tr>
<td>The commercial vehicle far from the bike lane (wider loading zone)</td>
<td>45</td>
</tr>
<tr>
<td>The commercial vehicle adjacent to the bike lane (narrow loading zone)</td>
<td>4</td>
</tr>
</tbody>
</table>
Data Collection (Eye Tracking)

ASL Mobile Eye XG
Results (TFD)

No CVLZ
Results (TFD)
Results (TFD)

Max CVLZ
Results (Total Fixation Duration)
Results (Total Fixation Duration)

AOI (Courier)

<table>
<thead>
<tr>
<th>Loading Zone Size</th>
<th>Courier Behind the Truck</th>
<th>Courier Beside the Truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean Total Fixation Duration (sec) with 95% CI
Results (Post Survey)

- Similar scenario exposure

"Before this experiment, have you ever had a conflict with a commercial vehicle in a bike lane (e.g., deliver trucks in the bike lane, presence of deliver courier)?"

- No: 8
- Yes: 40
- Unsure: 2

"Before this experiment, have you ever come upon an obstruction while riding in a bike lane (e.g., something blocking the bike lane, does not have to be a commercial vehicle)?"

- No: 5
- Yes: 45
- Unsure: 0
Results (Post Survey)

- Validating behavioral results

"Based on your experience avoiding obstructions in the bike lane in the real world, did you make a similar action to avoid the hazard in the simulator?"

<table>
<thead>
<tr>
<th>Participant Answer</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>39</td>
</tr>
<tr>
<td>Unsure</td>
<td>2</td>
</tr>
<tr>
<td>No</td>
<td>4</td>
</tr>
</tbody>
</table>

"What are your typical responses to avoiding obstructions in the bike lane?"

<table>
<thead>
<tr>
<th>Participant Responses</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop your bike and wait for the obstruction to clear</td>
<td>7</td>
</tr>
<tr>
<td>Ride onto the Sidewalk</td>
<td>19</td>
</tr>
<tr>
<td>Take the Travel Lane (Ride in the travel lane)</td>
<td>29</td>
</tr>
<tr>
<td>Ride between obstruction and traffic</td>
<td>26</td>
</tr>
<tr>
<td>Dismount your bike and walk around obstruction</td>
<td>4</td>
</tr>
</tbody>
</table>
Conclusion

- **Loading zone size and courier position** had the greatest effect on cyclist’s physiological responses.

- Cyclists had approximately 2 peaks per min higher when riding in the condition that included no CVLZ and courier on the side compared to the base conditions (i.e., Max CVLZ and no courier).

- When the courier was beside the truck, cyclist’s fixation durations (sec) were 1 second greater than when the courier was located behind the truck, indicating that cyclists were more alert as they passed by the courier.

- The presence of accessories had the lowest influence on both cyclists’ physiological response and eye tracking.

- About one third of participants decided to use the sidewalk.
Recommendations for Practice

- No divergence from bike lane
- Placing barriers on the left side of the bike lane
- Passenger side instead of driver side
- Policy considerations regarding the width of the bicycle lane
- Provision of an additional curb ramp
- Extra buffer in CVLZ for courier improves cyclist's performance measures positively

Can I Ride My Bike On The Sidewalk?
Acknowledgments

David Hurwitz, PhD
Hisham Jashami, PhD
Douglas Cobb, PhD, PE
Yujun Liu, MSCE Student
Ivan Sinkus, URA

Anne Goodchild, PhD
Ed McCormack, PhD

Funding support provided by PacTrans, USDOT Region 10 UTC.
Questions

David S. Hurwitz, PhD, F.I.E
Professor
Oregon State University
Email: david.hurwitz@oregonstate.edu