# Roundabout Access for Visually Impaired Pedestrians:

## Evaluation of a Yielding Vehicle Alerting System for Double-Lane Roundabouts

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# Problem for Pedestrians with Visual Impairment at Double-Lane Roundabouts

- Drivers Don’t Yield
- Conditions for Detecting Gaps by Sound are not Good
- Crossable Gaps May be Infrequent

# Approach: Two Studies

- Closed Course Evaluation of Pavement Treatment
  - Will pedestrians with severe visual impairment benefit from pavement treatment to alert them to the presence of stopped vehicles?
- Observations at operating Double-Lane Roundabout
  - Will pedestrians with severe visual impairment benefit from pavement treatment to alert them to the presence of stopped vehicles?
  - Can signage increase driver yields to pedestrians?

# The Alerting System

- 1.5 inch PVC Pipe secured to roadway with asphalt tape
- Three strips
  - Parallel to upstream edge of crosswalk
  - 20 ft upstream of crosswalk
  - 24 ft upstream of crosswalk
- Each strip generates a distinct clack when a wheel passes over it

# Nomenclature

- Both Lanes Blocked:
  - Two Vehicle Have Stopped, One Blocking Each of Two Exit Lanes
- Near Lane:
  - Right Lane
- Far Lane:
  - Left Lane

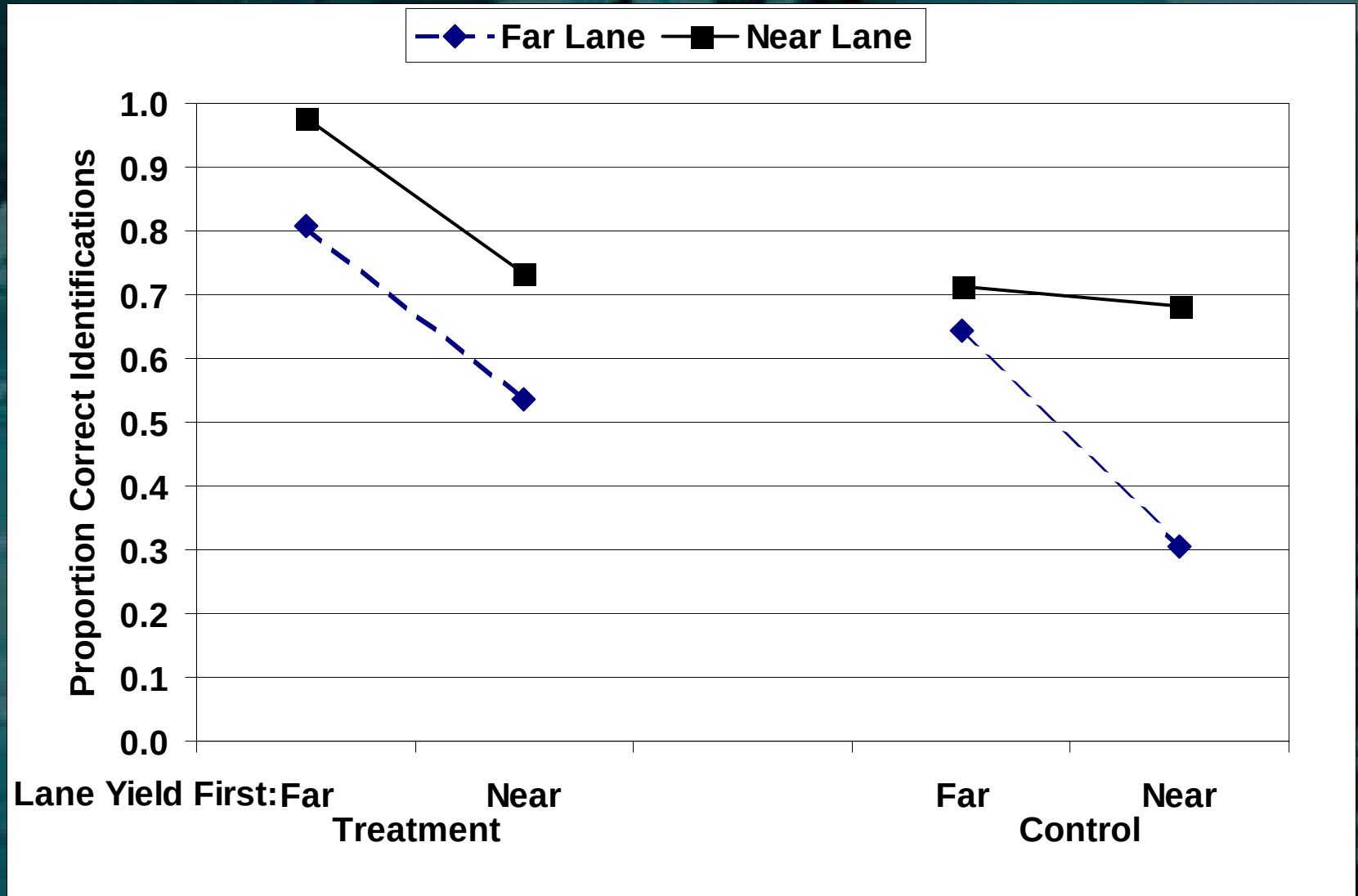
# Closed Course Evaluation

- Seven Participants with Severe Visual Impairment
- Two conditions: Treatment (with) and Control (without)
- 18 Trials in Each Condition
  - Near Lane Yields First – 8 trials
  - Far Lane Yields First – 6 trials
  - Both lanes yield together – 4 trials

# Results – Detection of Both Lanes Blocked

| Participant | Hits Control | Hits Treatment | False Alarms Control | False Alarms Treatment | Misses Control | Misses Treatment |
|---|---|---|---|---|---|---|
| 1 | 47% | 87% | 7% | 7% | 47% | 7% |
| 2 | 19% | 69% | 13% | 13% | 69% | 25% |
| 3 | 50% | 50% | 13% | 13% | 38% | 38% |
| 4 | 19% | 38% | 6% | 13% | 75% | 50% |
| 5 | 44% | 63% | 0% | 13% | 56% | 25% |
| 6 | 63% | 56% | 31% | 13% | 6% | 31% |
| 7 | 13% | 38% | 0% | 19% | 88% | 44% |
| **Mean** | **36%** | **57%** | **10%** | **13%** | **54%** | **31%** |

# Results – Correct Identifications by Lane



# Closed Course Conclusion

- Most Participants Benefited without Need for Training
  - Detections Increase, Misses Decrease, False Alarms Unchanged
  - False Alarm Rate is Potential Problem
  - Performance After Training was Not Evaluated

# Field Evaluation

- Evaluate Alerting System in Real World
- Observe Driver Response to Pedestrians with Visual Impairment
- Evaluate Effect of MUTCD R1-6 on Yielding Behavior

# Treatment Condition

# Roundabout

- Inscribed Circle Diameter 159 ft
- Exit has Two 16 ft Lanes
- Red Brick Textured Crosswalk
- ~ 800 Vehicles per Hour

# Procedure

- Control Condition:
  - Observations in Two Weeks Before Treatment Between 5 and 6:30 PM
- Treatment Condition:
  - Observations Between 3:30 and 5 PM

# Trial

- Trial Ends When:
  - Participant Detects Both Lanes Block (whether correct or not)
  - Either Lane Blocked for 10 s or More and Traffic Backs Up
  - Participant Fails to Detect Both Lanes Blocked within 10 s
  - Good Samaritan Intervenes
  - Three Minutes Elapse without a Detection

# Results – Driver Behavior

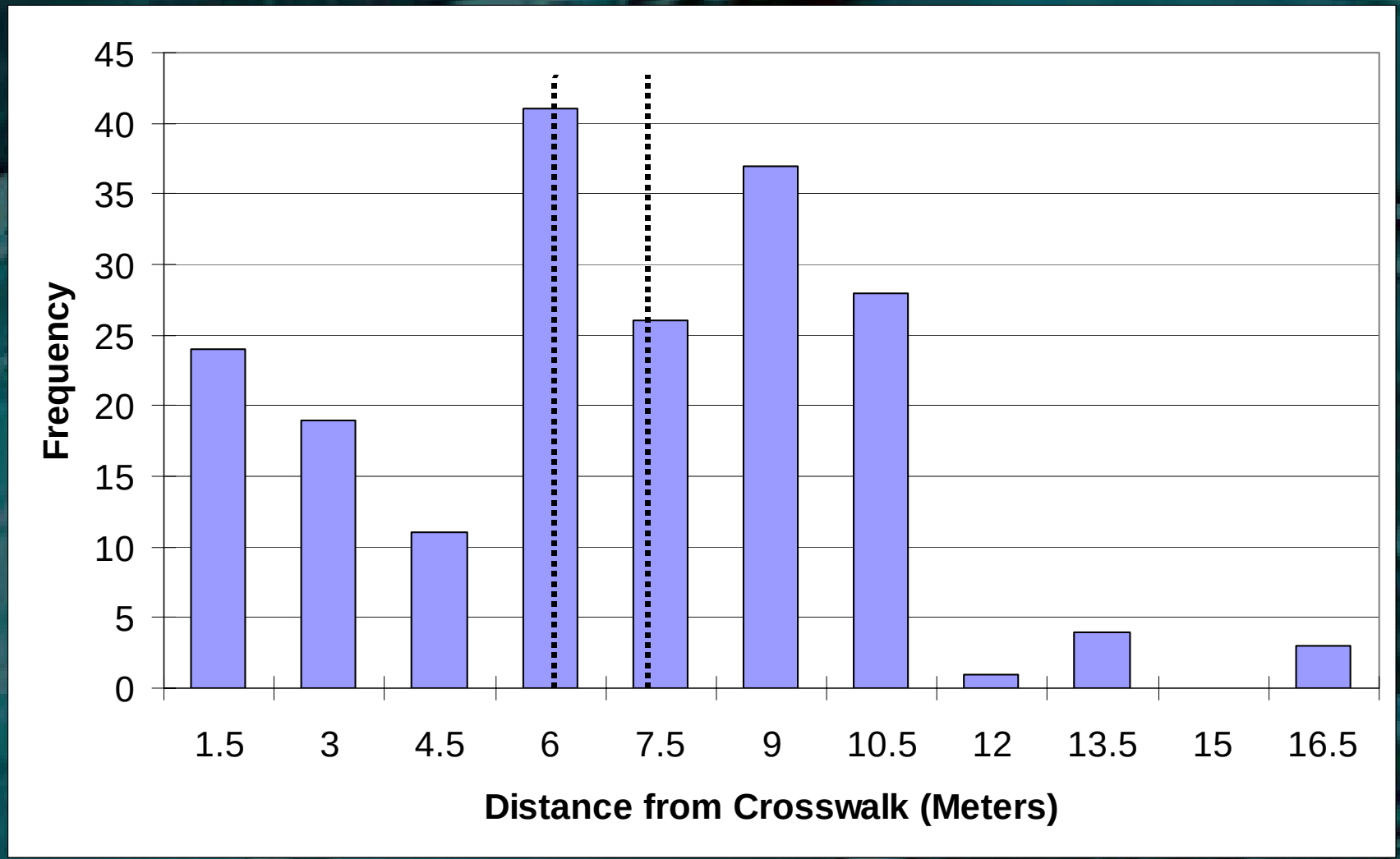
| *Driver Behavior* | *Control* | *Treatment* | ***Total*** |
|---|---|---|---|
| Stopped | 115 | 158 | 273 |
| Continued without Stopping | 881 | 790 | 1671 |
| **Total** | 996 | 948 | 1944 |

- Mean Time of Stop
  - Control Condition: 10.8 s
  - Treatment Condition: 4.7 s

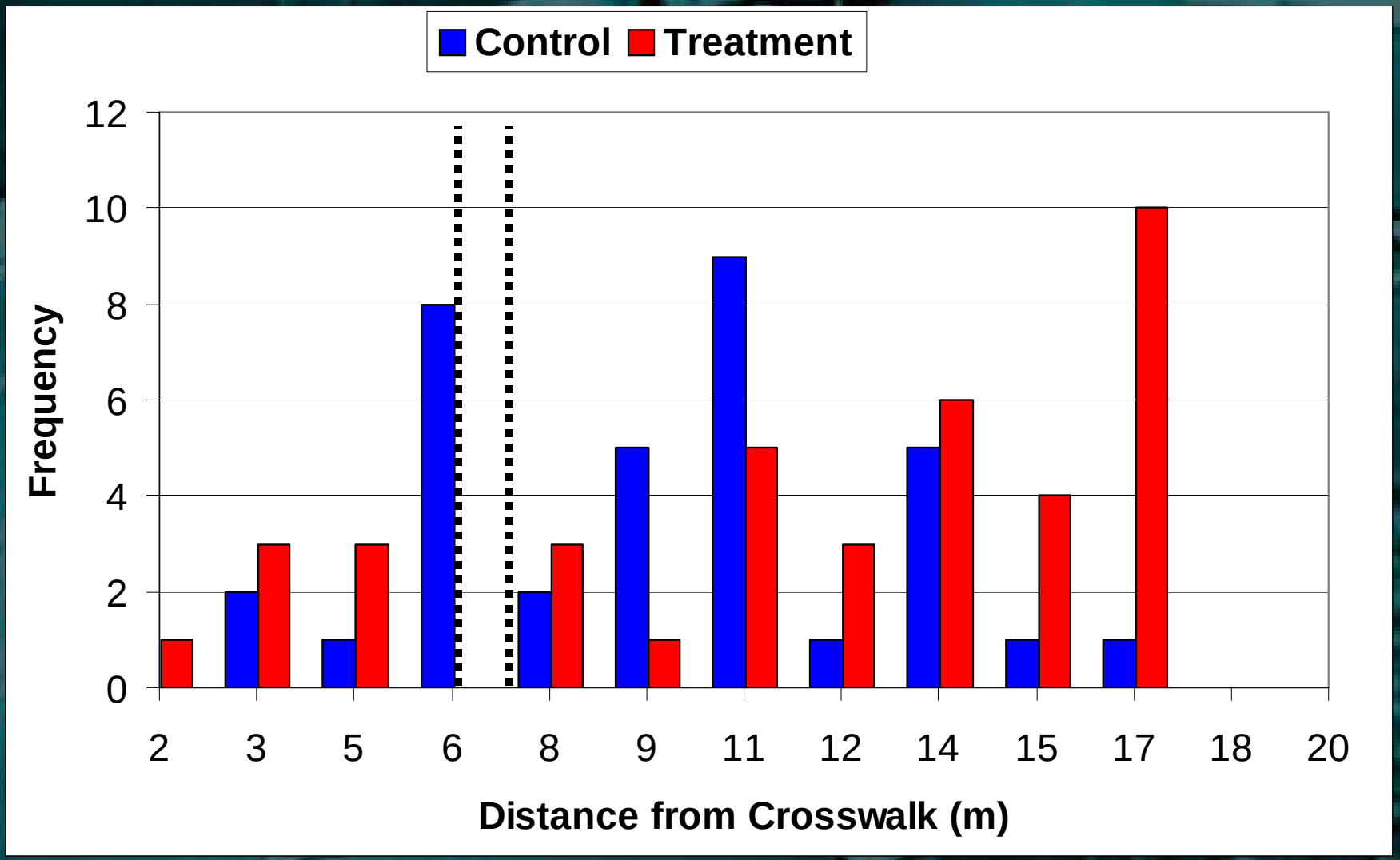
# Results – Crossing Outcomes

| Participant | Control Hits | Treatment Hits | Control False Alarm | Treatment False Alarm | Control Time Out | Treatment Time Out | Control Miss | Treatment Miss | Control Good Sam | Treatment Good Sam |
|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 19% | 20% | 19% | 7% | 13% | 7% | 19% | 27% | 31% | 40% |
| 3 | 43% | 14% | 36% | 14% | 14% | 43% | 0% | 24% | 7% | 5% |
| 4 | 8% | 6% | 17% | 0% | 8% | 50% | 33% | 25% | 33% | 19% |
| 5 | 15% | 6% | 0% | 0% | 38% | 56% | 0% | 13% | 46% | 25% |
| 7 | 10% | 11% | 0% | 6% | 50% | 28% | 0% | 39% | 40% | 17% |
| ***Mean*** | 19% | 12% | 14% | 5% | 25% | 37% | 32% | 21% | 10% | 25% |

# Most Vehicles Stopped without Triggering Alert (near lane)



# Far Lane Stops – Distance to Crosswalk



# If Participants Could Immediately Detect Both Lanes Blocked, How Long Would They Need to Wait?

| | *Time (min:sec)* | *# Passing Veh.* |
|---|---|---|
| Max | 4:05 | 47.0 |
| Min | 0:00 | 0.0 |
| Average | 1:03 | 8.9 |
| 15th %ile | 0:16 | 0.0 |
| 85th %ile | 2:05 | 19.1 |
| Number of Trials | 74 | |

- Record Time from Beginning of Trial Until both Lanes are Blocked
  - Exclude Trials Where Good Samaritan Interfered
  - Exclude Trials that End in Timeout

# Conclusions

- The Alerting System Can Improve Detection If It is Triggered
  - This was True Without Training
- The Alerting System Did Not Eliminate False Alarms
- Drivers Often Stop Far from the Crosswalk
- In Street MUTCD R1-6 May Increase Stopping, but Not Patience

# Recommendations

- Examine Effect of Crosswalk Setback on Where Drivers Stop and Where Pedestrians Cross
- Evaluate Alerting System for Single-Lane Roundabouts Where False Alarms are Less Likely to be a Problem

# For Further Information Contact

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