

# **Motorcycles are not invisible; Oncoming drivers misjudge when it is safe to turn**

B. Sager<sup>1</sup>

E. Kreykenbohm<sup>2</sup>

M.R.Yanko<sup>1</sup>

T.M.Spalek<sup>1</sup>

D.J. Froc<sup>2</sup>

D.M. Bernstein<sup>2</sup>

F.N. Dastur<sup>2</sup>

<sup>1</sup> Simon Fraser University

<sup>2</sup> Kwantlen Polytechnic University

# Contents

- Introduction: What is a Right-Of-Way violation collision?
  - Example
  - Possible Causes
- Testing Motorcycle Conspicuity
  - Experiment 1: Change Blindness
- Testing Decision Making
  - Experiment 2a: Gap Acceptance
  - Experiment 2b: Dynamic Gap Acceptance
- Conclusions
- Questions

# Fatal Collisions (U.S. 2011)

- 1,998 two-vehicle crashes involving motorcycles
- 757 (38%) where the other driver turned left across the path of the motorcyclist

# ROW Violation Collision Example



# Are Motorcycles Invisible?

- Drivers claim to not have seen the bike until too late
- Underrepresented in collision statistics:
  - Large touring motorcycles with fairings
  - High-visibility jackets



# Testing Conspicuity

- Conspicuity: An object's ability to capture attention
- Factors affecting conspicuity:
  - Brightness / Contrast
  - Size
  - Frequency
- Are motorcycles not bright enough?
- Are motorcycles not large enough?
- Are motorcycles not frequent enough?

# Change Blindness

- Inability to detect changes to an object or a scene, even when those changes are large, repeated, and anticipated (Rensink, 2002)
- Change Blindness provides a test of attention that can be used to study motorcycle conspicuity

# Change Blindness Demo



# Experiment 1: Change Blindness

- 52 participants
- 30 trials
- 5 conditions:
  - No change
  - Car
  - Motorcycle
  - Pedestrian
  - Driving-irrelevant object

# Predicted Detection Rates

- If motorcycles are inconspicuous due to size:  
Cars > Motorcycles > Pedestrians
- If motorcycles are inconspicuous due to rarity:  
Cars = Pedestrians > Motorcycles

# Stimuli



# Car





# Motorcycle





# Pedestrian

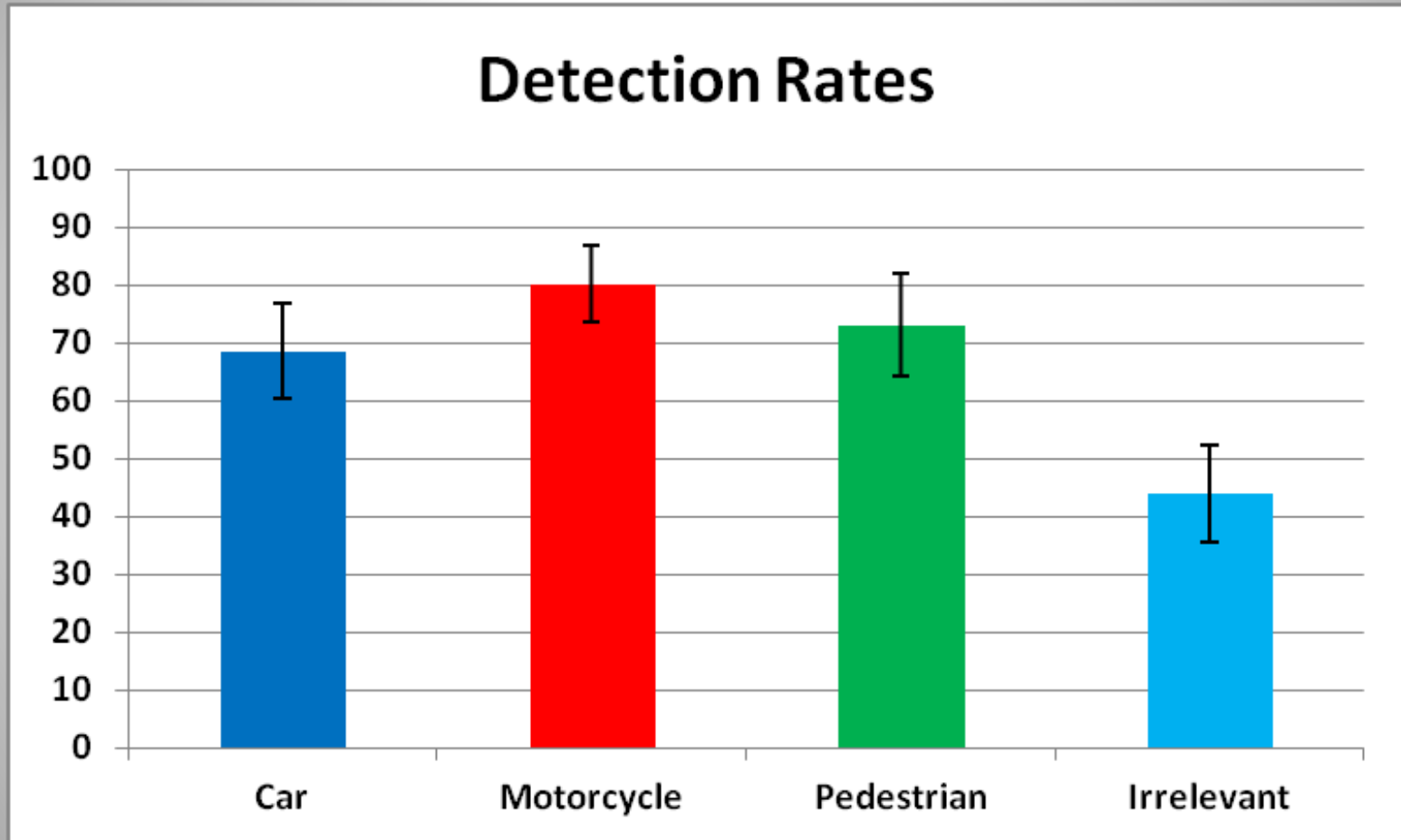




# Irrelevant



# Experiment 1 Results (n=52)



Error bars represent 95% C.I.

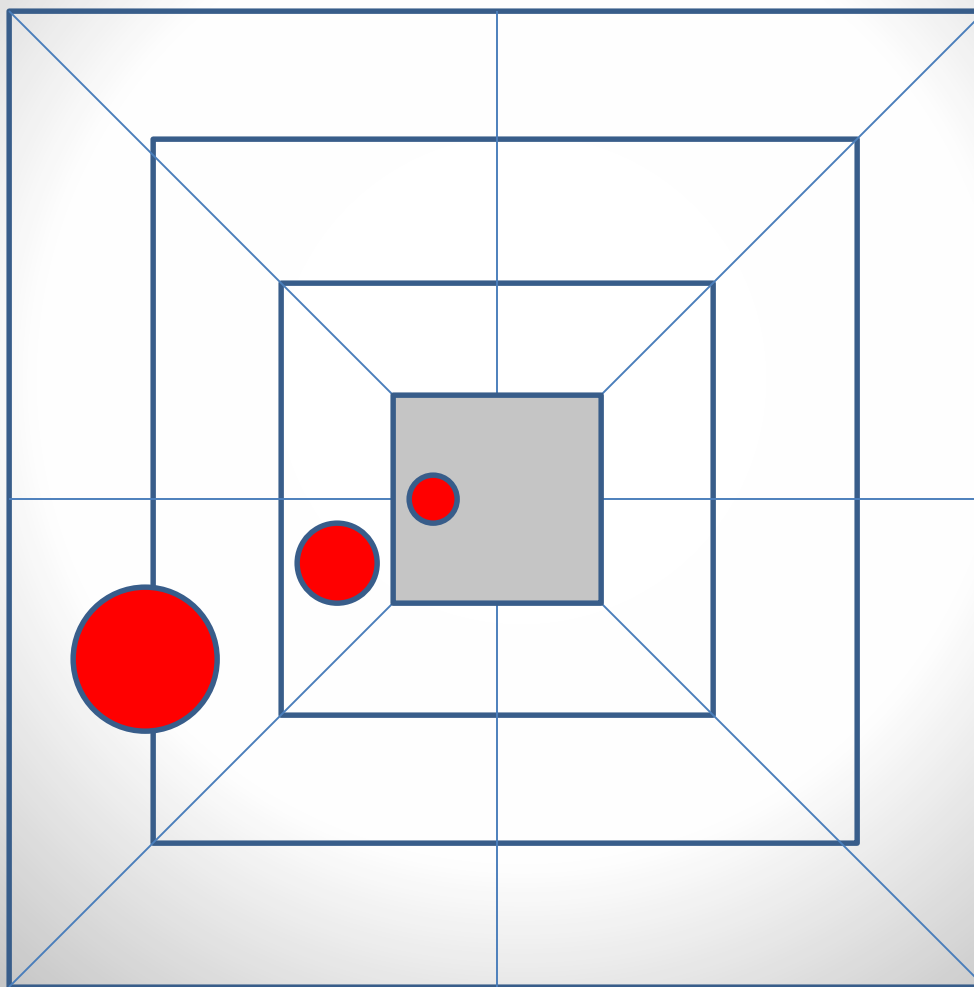
# Experiment 1 Results

- Predicted detection rates:
  - If motorcycles are inconspicuous due to size:
    - Cars > Motorcycles > Pedestrians
  - If motorcycles are inconspicuous due to rarity:
    - Cars = Pedestrians > Motorcycles
- But ...
  - Motorcycles = Pedestrians > Cars

# Experiment 1 Discussion

- Motorcycles do not suffer a lack of conspicuity
  - Detection rates unrelated to:
    - Brightness, size, or frequency
- Other causes for collisions?
  - Judgement errors
  - Fewer motion cues based on lane position

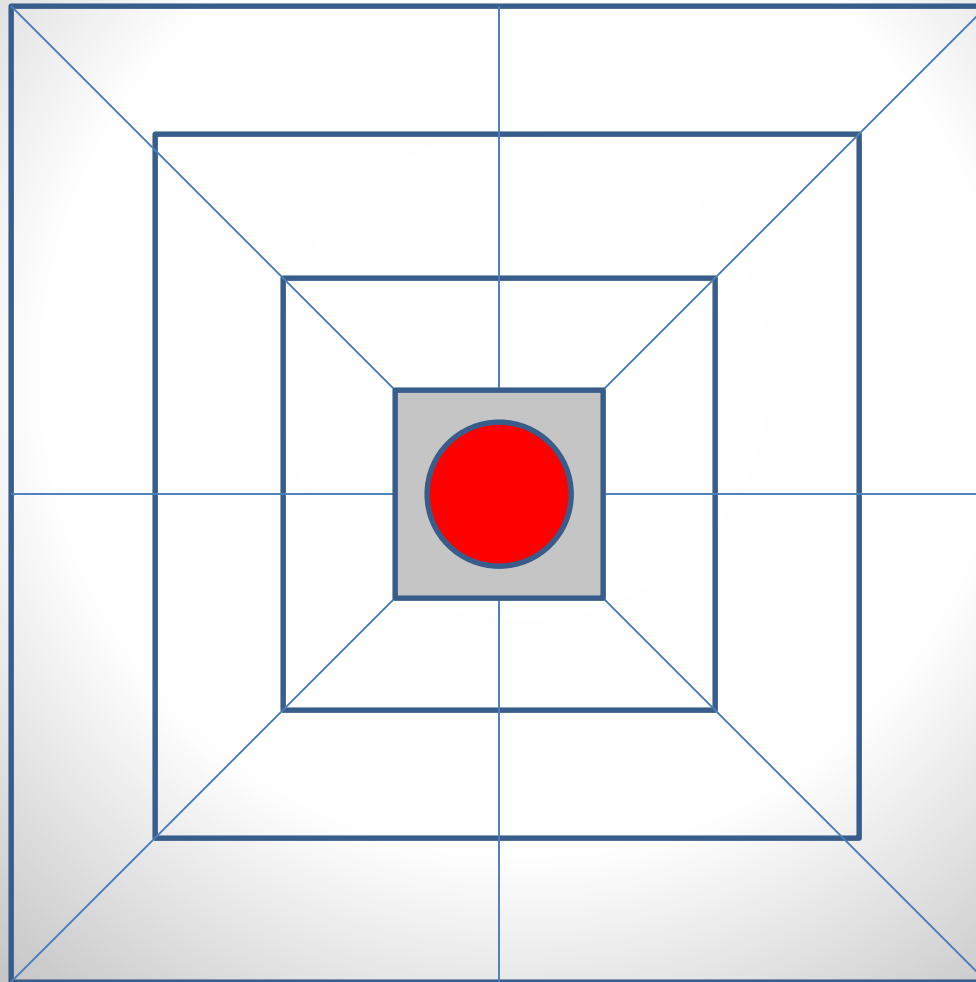
# Multiple Motion Cues:



# Motorcyclists Taught to Ride Here



# Single Motion Cue: Looming



# Experiment 2a: Gap Acceptance

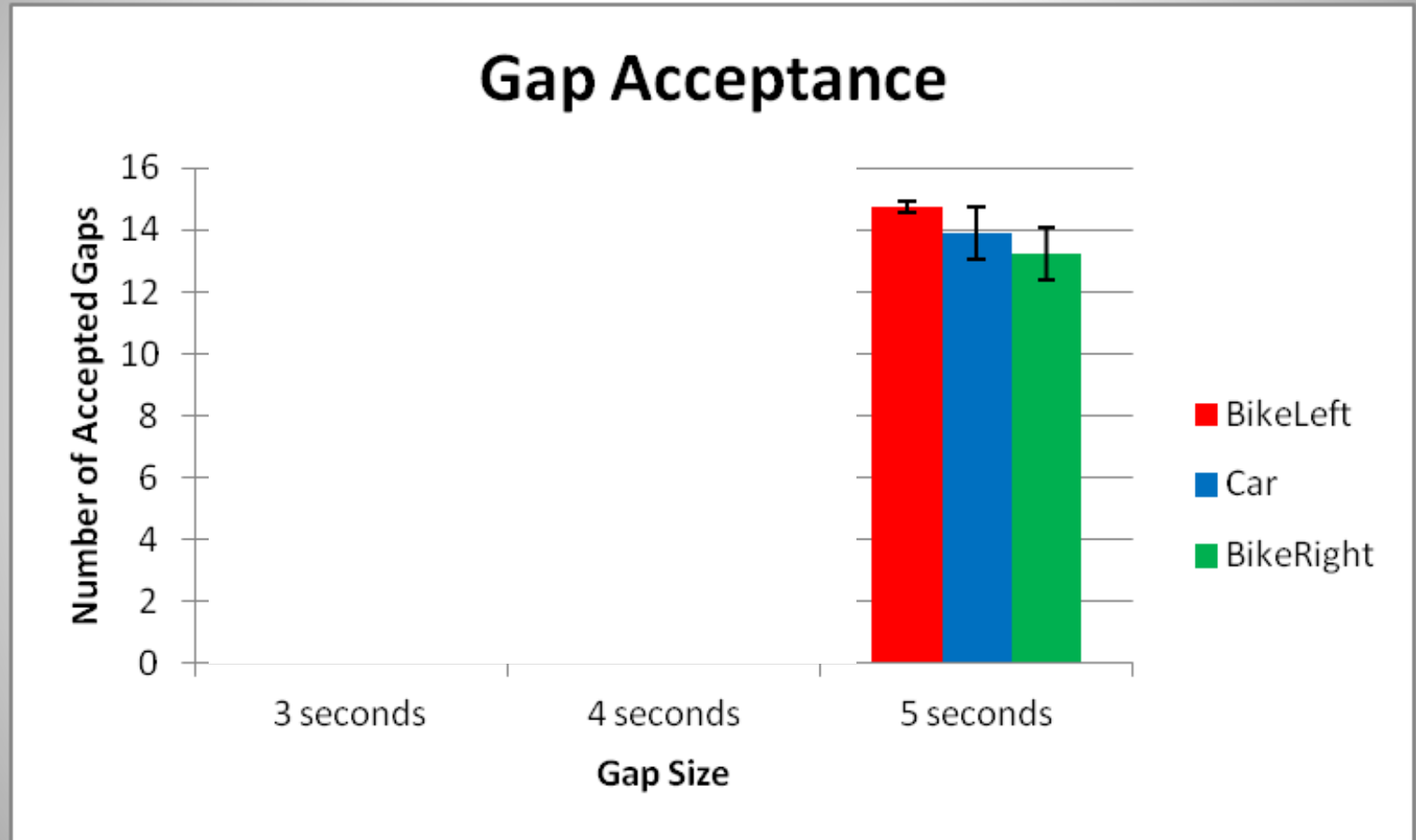
- Gaps:
  - Unsafe (<3s)
  - Ambiguous (4s)
  - Safe (5s)
- 17 Participants
- 135 Trials
  - Motorcycles in the **left-of-lane** position
  - Motorcycles in the **right-of-lane** position
  - **Cars**



# Experiment 2a: Gap Acceptance



# Experiment 2a: Results



Error bars represent S.E.M.

# Should Motorcyclists Ride Here?



# Experiment 2a: Discussion

- When uncertain about gap safety, drivers prefer to turn in front of a motorcycle in the left-of-lane position
- Limitation: Drivers were stopped at an intersection and never actually made the turn
- What happens as drivers approach an intersection and prepare a left turn?

# Experiment 2b

- Dynamic left-turn:
  - Simulated car driven in urban environment
  - 57 participants, 7 trials (left turns)
- No oncoming traffic
  - Left-turn unimpeded
- Oncoming traffic
  - Participant must yield to
    - Motorcycle in right-of-lane
    - Motorcycle in left-of-lane
- Dependent measure:
  - Longitudinal deceleration ( $\text{m/s}^2$ )

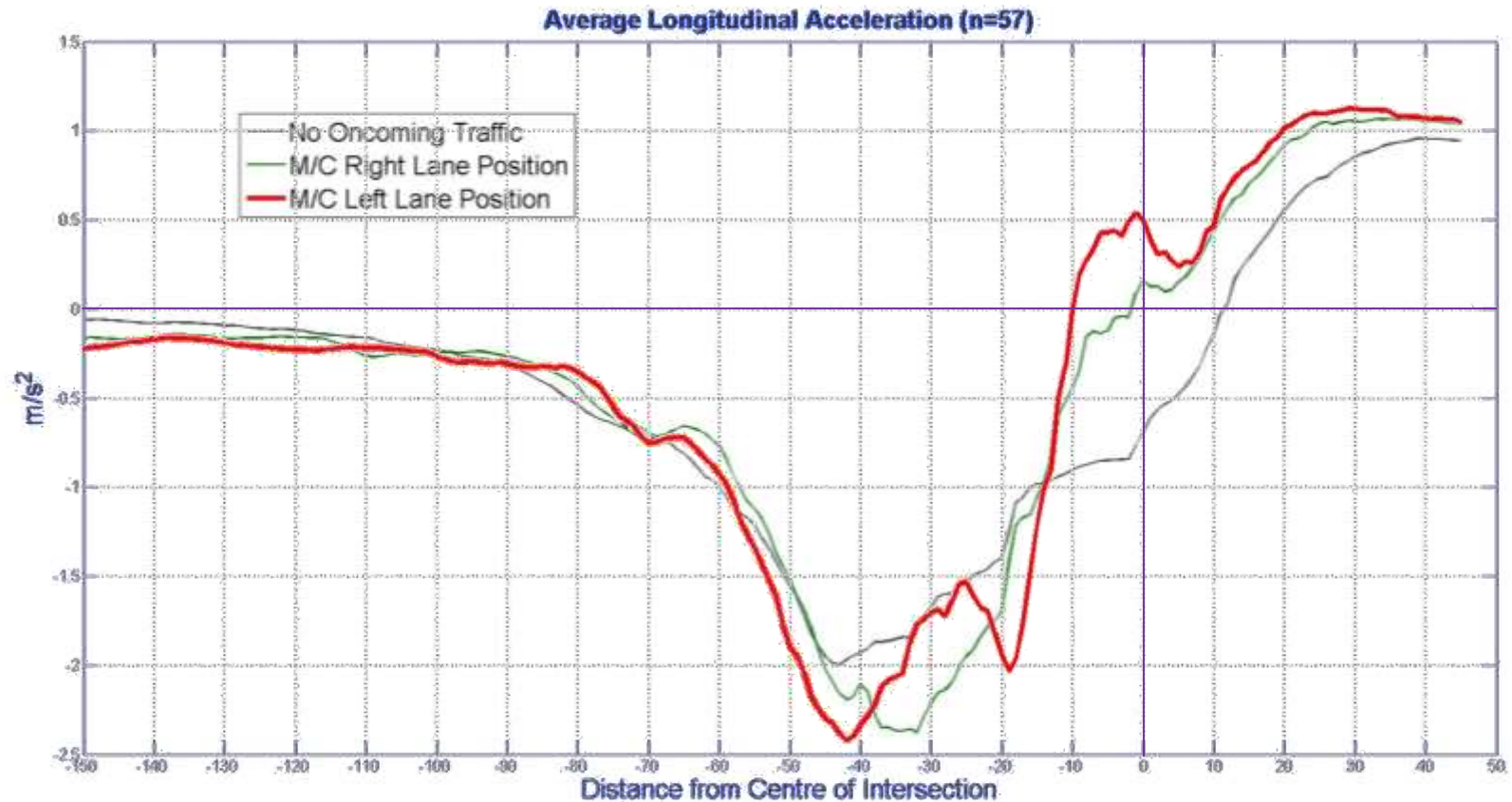


Image from drivesafety.com

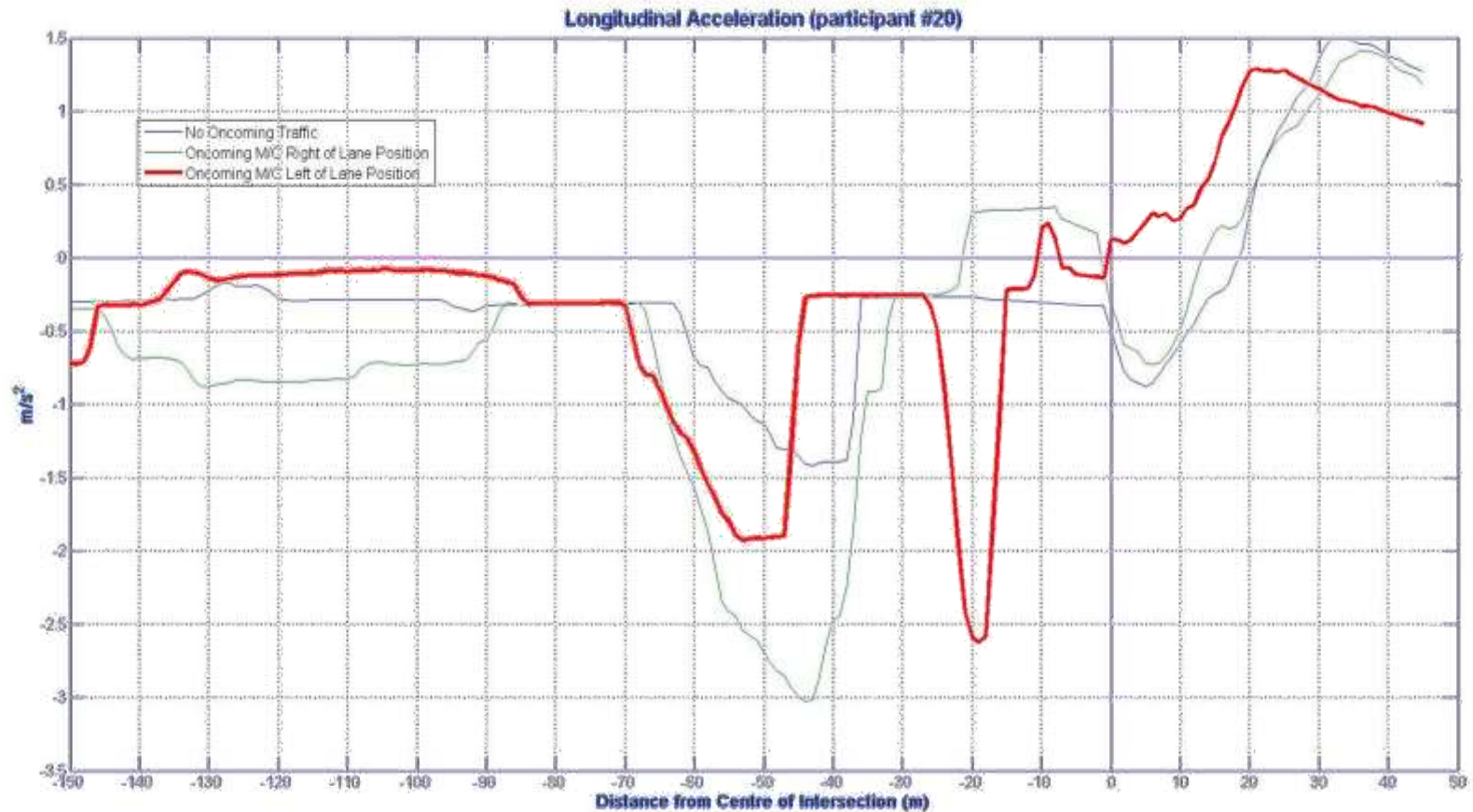
# Experiment 2b: Dynamic Left Turn

- Participants (n=57) turn left at intersections
  - No oncoming traffic
  - Oncoming vehicle on collision course:
    - Motorcycle in left-of-lane position
    - Motorcycle in right-of-lane position
  - Examine their deceleration profile
    - Analyze area under the curve

# Experiment 2b: Results



# Experiment 2b: Single Participant Data



# Experiment 2b: Discussion

- When confronted with a motorcycle in a left-of-lane position, participants:
  - Stop decelerating sooner
  - Readjust their braking abruptly
  - Accelerate harder after the event
- This suggests:
  - Motion-camouflage
  - Uncloaking
  - Emotional response

# Conclusions

- Motorcycles do not suffer a lack of conspicuity
- Motorcycles approaching intersections in a left lane position might be motion camouflaged from the perspective of an oncoming driver
- Motorcyclists may want to consider approaching intersections in a right lane position when there is the possibility of an oncoming driver turning left

# Thank You

- Dr Vincent Di Lollo, for valuable advice
- Regard Booy (RA)
- You, for your attention
- This research was supported by:
  - Kwantlen Katalyst Grant
  - Canada Research Chairs Program
  - Canada Foundation for Innovation
  - British Columbia Knowledge Development Fund

# Questions?