Exploring Human Factors: The MSF100 Motorcyclists Naturalistic Study

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The paper summarizes how naturalistic research studies can add to our understanding of the role of human factors in traffic safety outcomes. Motorcyclists make choices in the bikes they ride, the types of trips they take, when and where they ride, the reasons they ride, and the gear they wear, to name a few. The paper explores how these human choices can and do affect rider incidents and can inform the ongoing development of rider training systems.

Exploring Human Factors:

The MSF100 Motorcyclists Naturalistic Study

Conducted by Virginia Tech Transportation Institute

DO NOT DISTRIBUTE

Preliminary results only

Human Factors in Traffic Safety

- The application of knowledge about human abilities, limitations, and other human characteristics to the design of equipment, tasks, and jobs.
- How drivers (riders) perform as a system component in the safe operation of vehicles.
- Driver (rider) performance is influenced by many environmental, psychological, and vehicle design factors.

NHTSA

Why Study Human Factors

- Fewer accidents
- Fewer near misses
- Reduced potential for human error and its consequences
- What is possible for humans acting within this traffic environment? What is not?
- What should be included in training? In vehicle design?

Naturalistic Study / Human Factors

- Not an experimental setting or a simulated environment
- Personally-owned motorcycles
- Unobtrusive instrumentation
- Participant-driven riding choices
- Continuous measurement (key on – key off)
- Not dependent on participant recall
- Varying skill levels, experience levels, personality types, motorcycle types

MSF100 Study Overview

- Recruited 100 riders
- Models represented market
- Instrumented personal motorcycles
- No further instructions or interactions
- Notify study sponsor if an incident occurred
- Small stipend for participation
- Ingest data into VTTI system
- Analyze DATA for DECADES!!


Video: Forward
Video: Rear
MSF
MOTORCYCLE SAFETY FOUNDATION
100 Motorcyclists Naturalistic Study
conducted by
VirginiaTech
TRANSPORTATION INSTITUTE

Number of Participants in Four Regions

- Blacksburg Virginia
  - Fall and Winter
  - Two-lane with hills and curves
  - Geographic overlap with automotive studies
- Orlando Florida
  - Conditioned helmet law
  - Mandatory training
  - Flat and straight roads
- Irvine, California
  - Year-round riding
  - Mixed traffic densities
  - Geographic overlap with past m/c studies
- Phoenix, AZ
  - Sports bikes
  - No helmet law

Motorcycle Instrumentation

- 5 Video cameras
- Lane tracking
- Helmet / Gaze tracking
- Front and rear brake
- Accelerometers (3 axes)
- Gyro (3 axes)
- Speed
- Turn signals
- GPS
- Forward radar (speed to lead vehicle/object; distance to lead vehicle – up to 255)
- Continuous collection
- 8-12 month capacity

Instrumentation: Unobtrusive Integration

MSF100 Data Summary

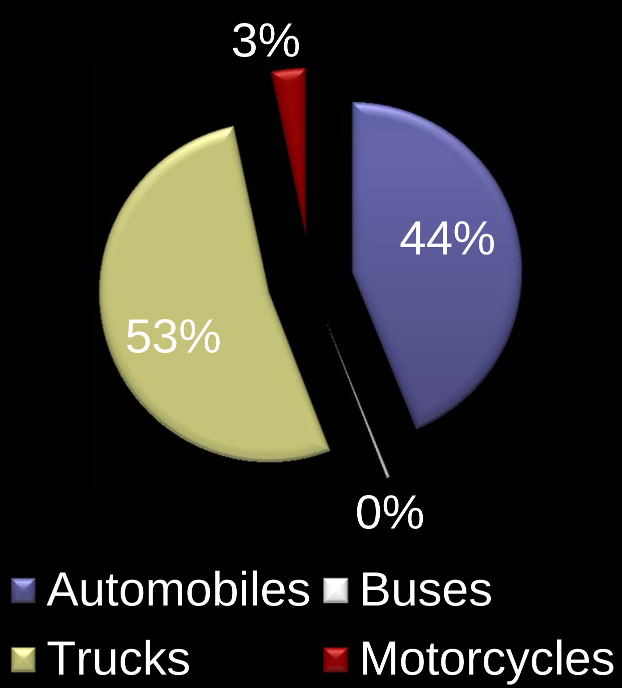
- Trips
  - 38,581
- Minutes of riding
  - 568,700
- Miles
  - 363,000
- Years (days of participation)
  - 100.6
- Data points
  - At least 40 billion data points not including the video streams

Human Factors

- "Static"
  - Demographics
  - Geographical
  - Vehicle design
- "Fluid"
  - Rider abilities
  - Rider judgment
  - Rider choices – made moment-by-moment
- WHEN, WHERE, in WHAT Weather, at WHAT Time, with WHAT protective gear

Motorcycle Owners - National

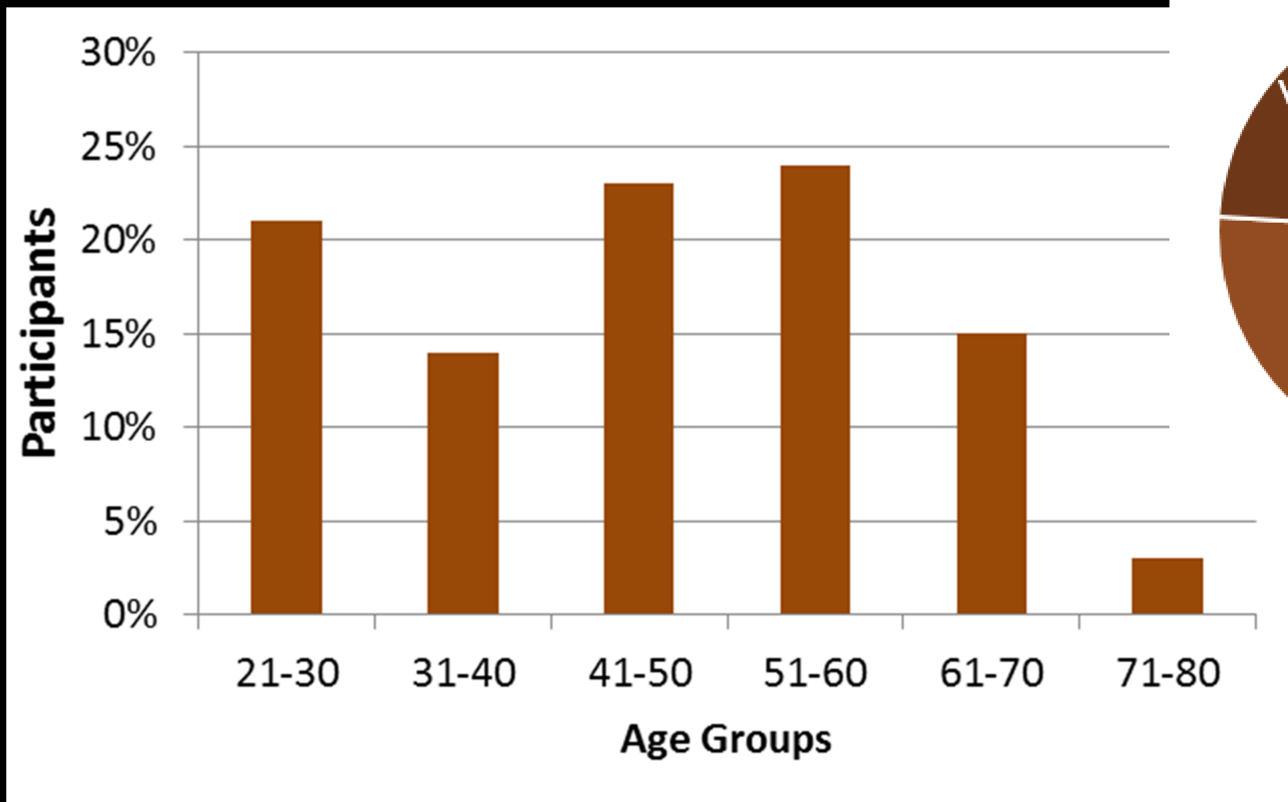
Registrations

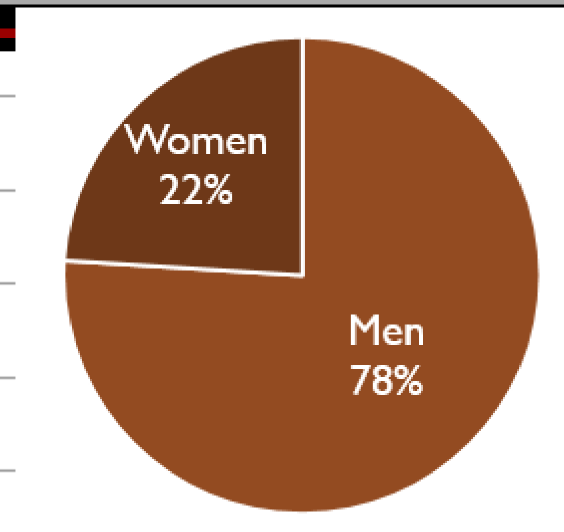


- Median age: 45
- White (75%)
- Married (63%)
- $64,000 annual income
- Owns 1.4 motorcycles
- Educated (76% some college or more)
- Licensed (87%)
- Primary means of transport: 38%
- 3000 annual miles
- Not taken Rider Ed course (49%)

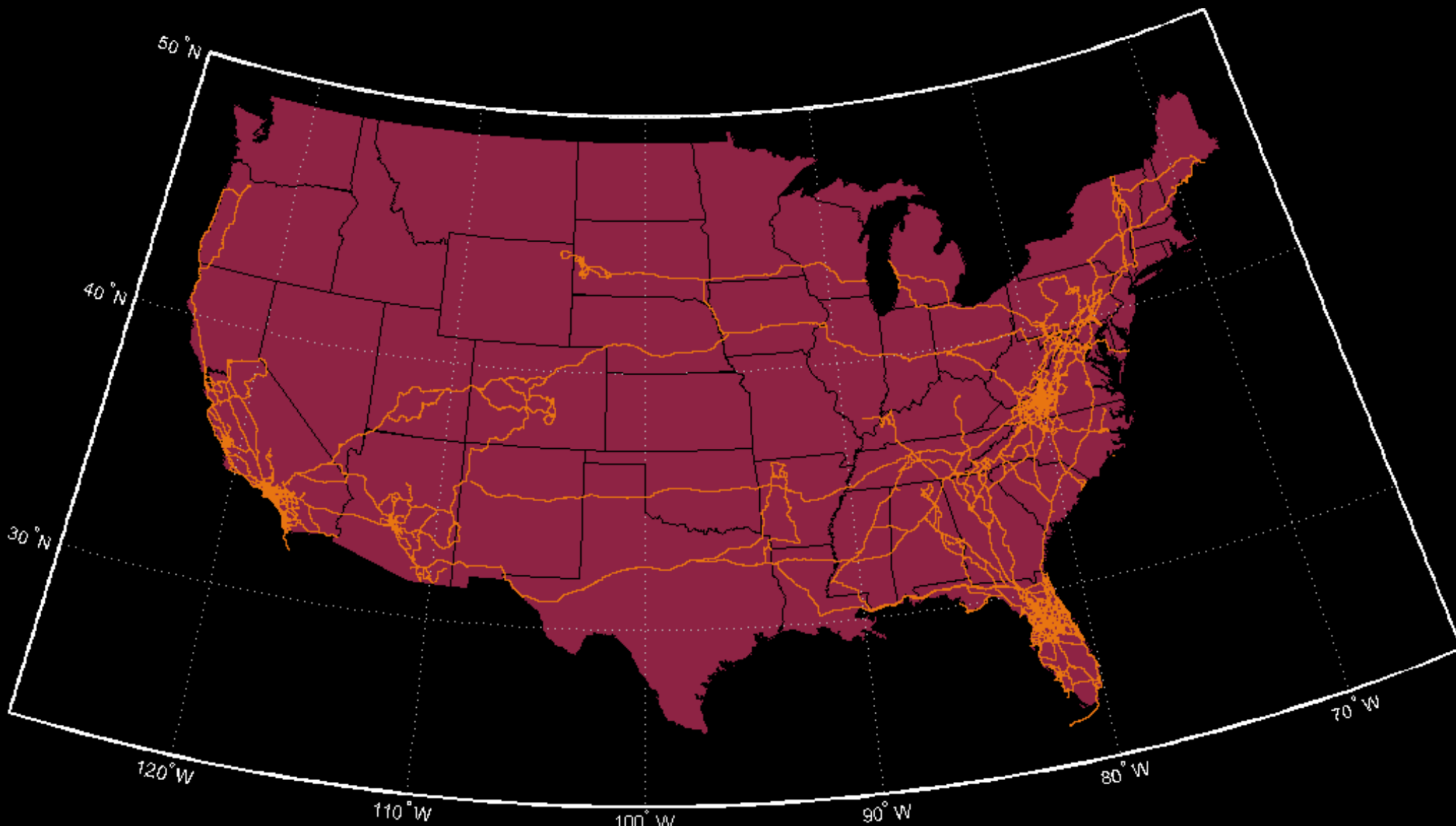
MIC 2012 Motorcycle/ATV Owner Survey

MSF100 Sample: Age and Gender

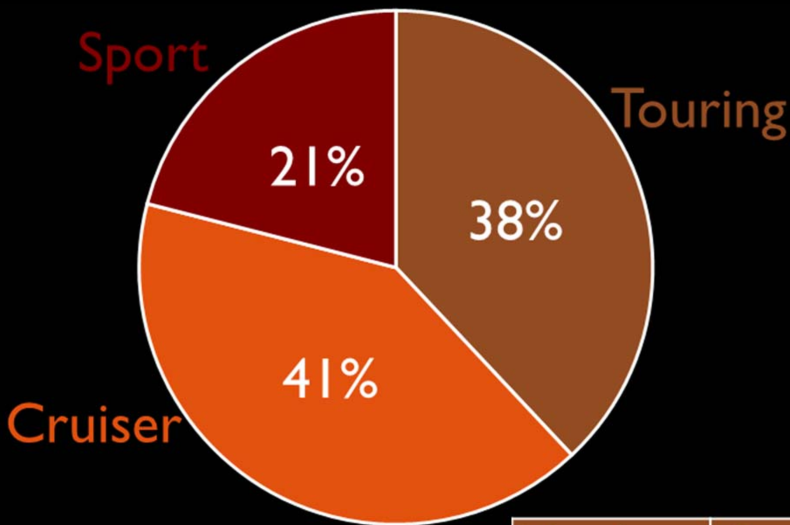




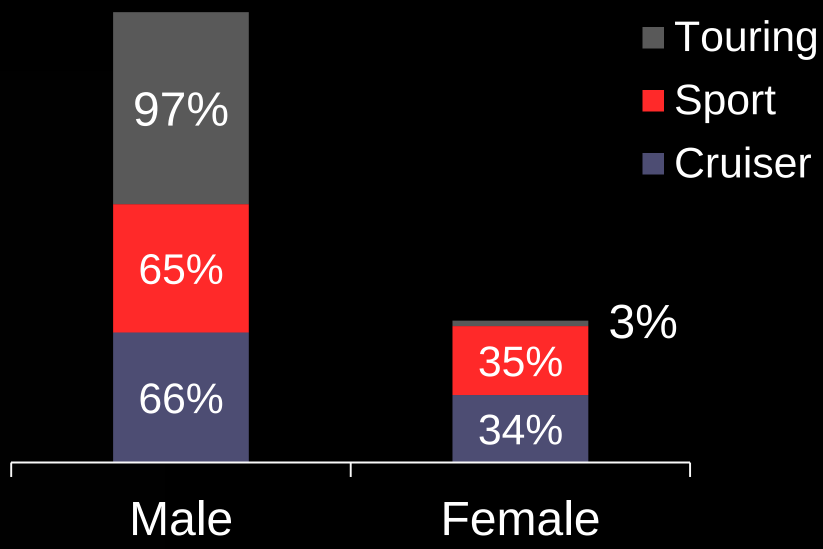
Geographic Factors: WHERE to ride



Motorcycle Types



Motorcycle Type by Gender



Touring	Cruiser	Sport
1600 cc	250 cc	600 cc
1800 cc	650 cc	1000 cc
	950 cc	
	1200 cc	

Does Personality Matter?

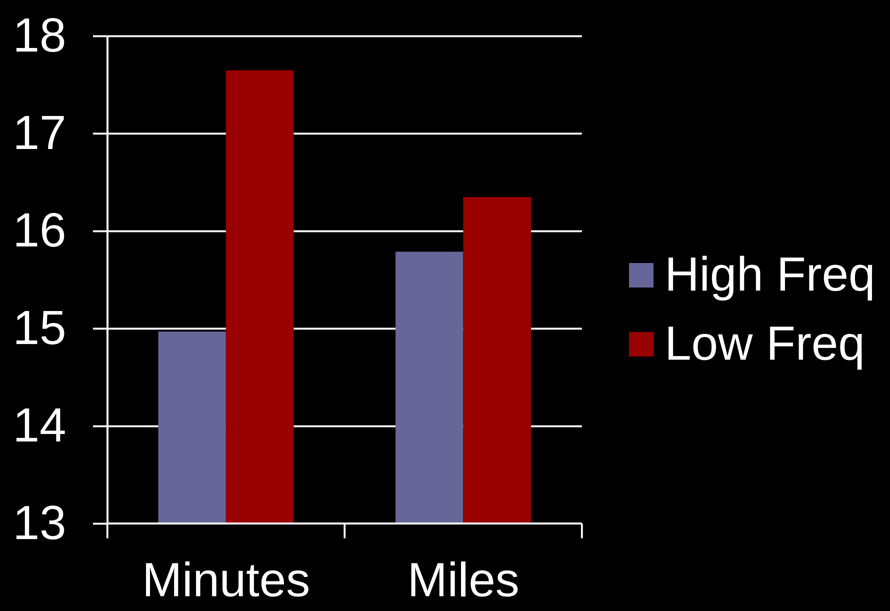
- Looked at Bike Type
  - There don’t appear to be differences between bike types except for Touring bike riders had slightly lower levels on the Neuroticism Scale of the NEO-FFI
- These measures may become more interesting when considered along with riding data.

Fluid Human Factors

- Motorcyclists make Choices
  - Some reduce / manage risk
  - Others increase risk
- Variation in rider choices
  - Frequency of trips
  - Time of day
  - Speed
  - Gear choices
- Reactions – Proactive Choices

Averages per trip

- Length of trip similar
- Time difference may be due to speed



High and Low Frequency Riders

		Mean	Minimum	Max
High Frequency	Trips	722	361	1491
	Miles	6,784	1,241	16,228
Low Frequency	Trips	160	11	343
	Miles	1,802	79	7,793
Total	Trips	447	11	1,491
	Miles	4,340	11	16,228

Sample Descriptors: WHEN to ride

Trip and Participant Distribution

Time of Day	Number of Trips	Percentage of Trips	Number of Participants	Percentage of Participants
Twilight AM	51	4.2%	16	34.8%
Day	653	53.9%	46	100.0%
Twilight PM	219	18.1%	39	84.8%
Night	288	23.8%	36	78.3%
	1211	**100%**		

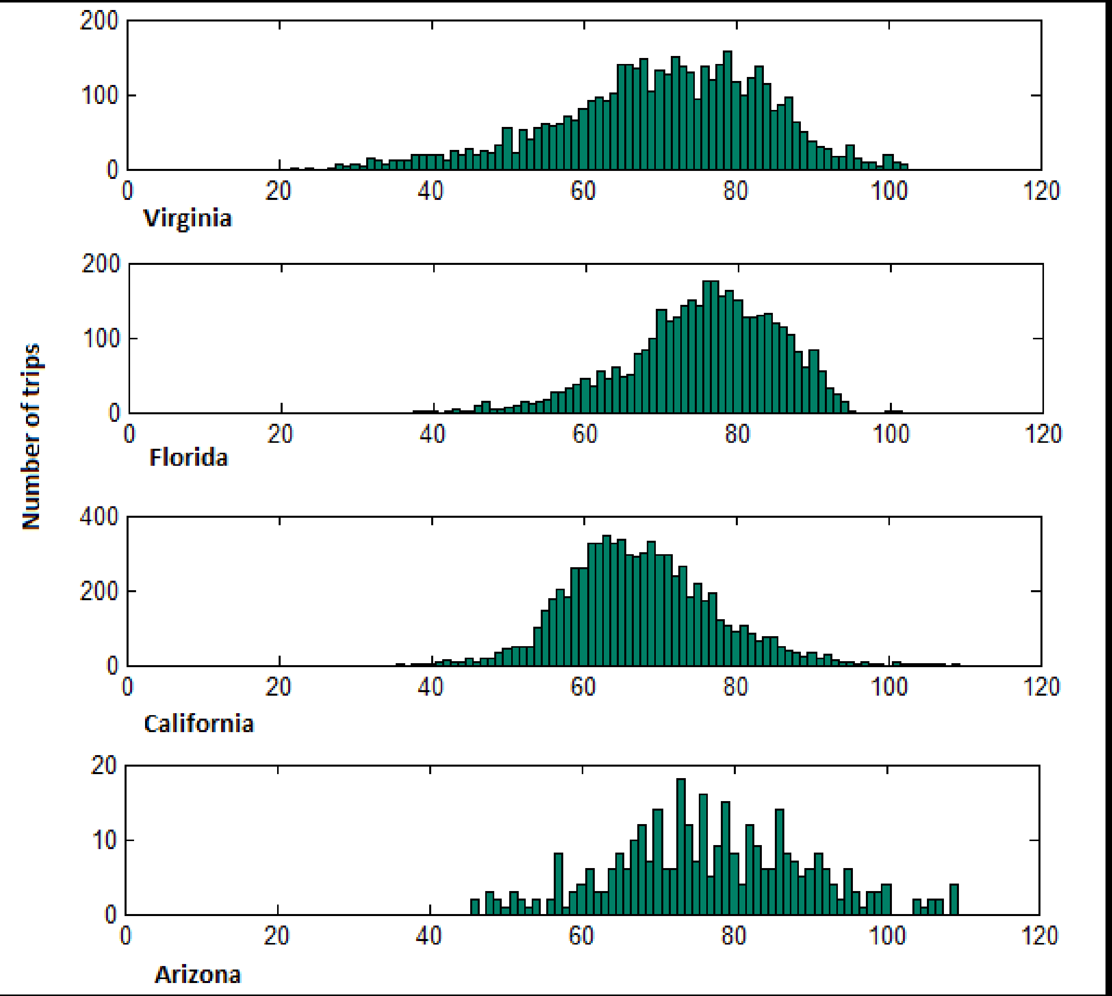
Rider Choices: Temperatures and Precipitation

Virginia

Florida

California

Arizona



20 40 60 80 100

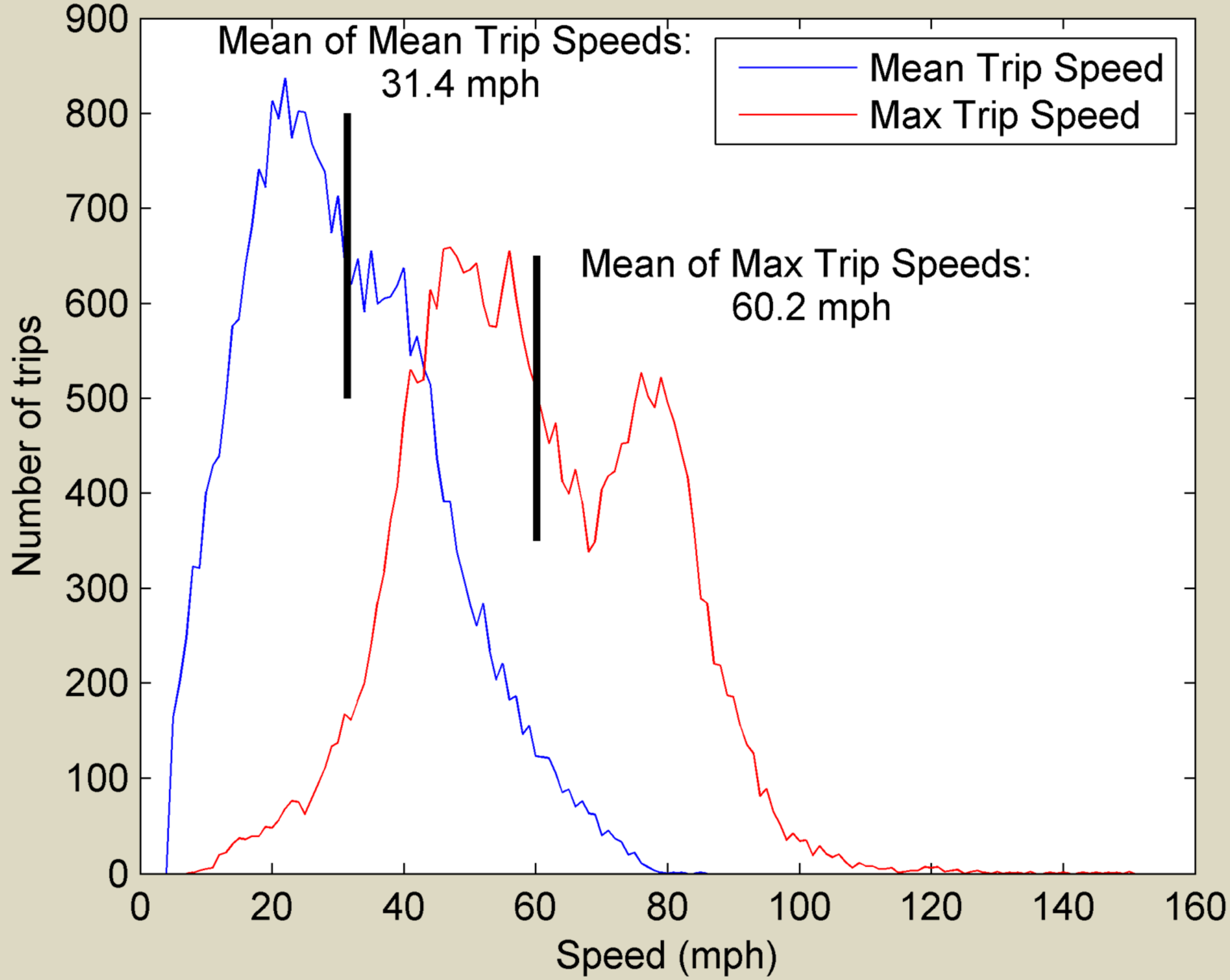
Temperature (ºF)

Rider Choices: In WHAT Weather

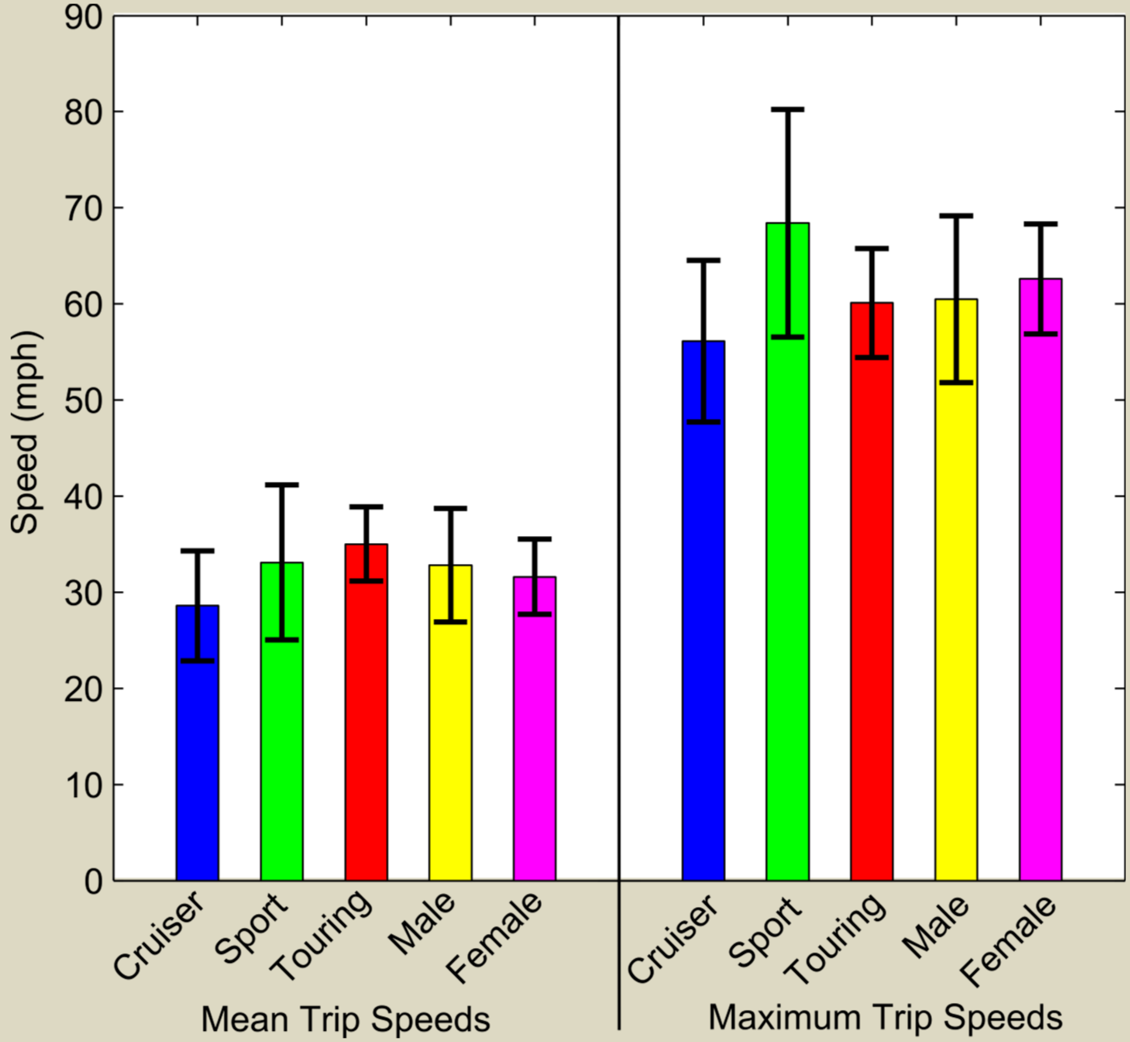
- Location has strongest influence
- 95% of rides occurred between 50°F and 90°F
- $\bar{x}$=70°F
- Extreme warmest rides in data set
  - 2.5% of trips between 90°F and 109°F
- Extreme coldest rides in data set
  - 2.5% of trips 50°F and 15.8°F
- 3% of trips at time of nearby precipitation.

- Future: Analysis of extremes

Rider Choices: Mean of Mean, Mean of Max Trip Speed



Mean & Max Trip Speeds by Gender



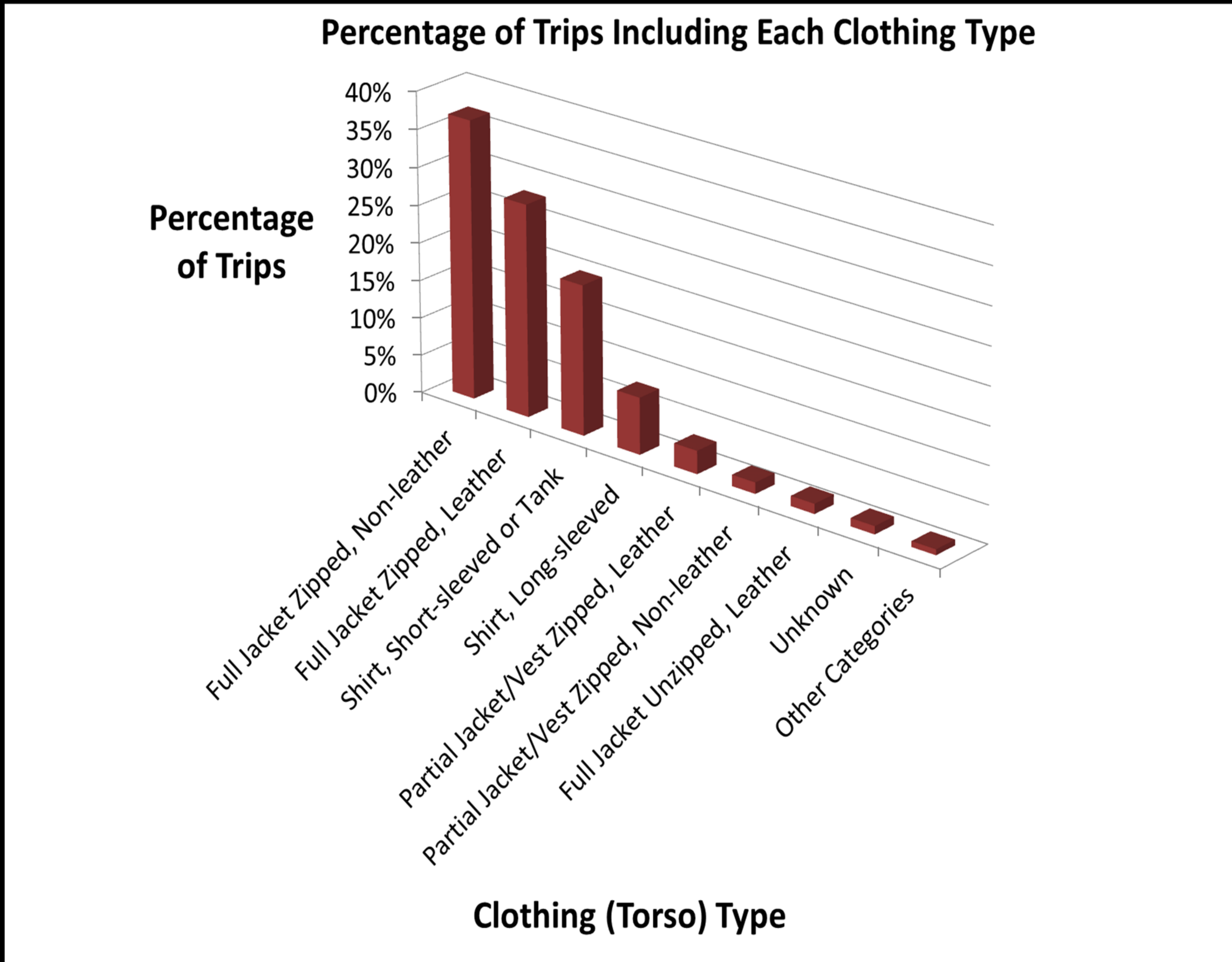
No significant differences:

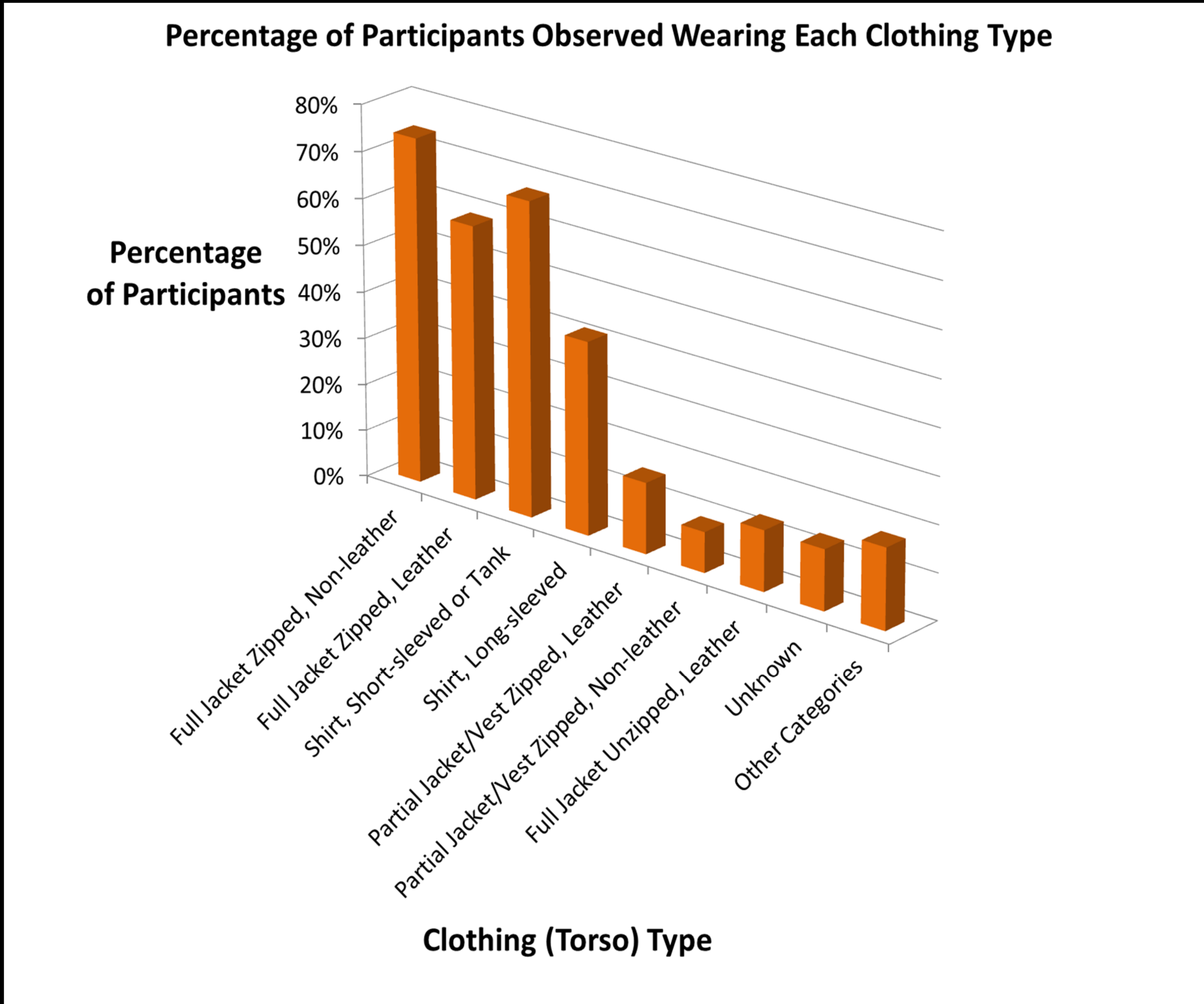
Mean or Max

Four participants were recorded riding at speeds in excess of 140 mph, some of them multiple times.

Rider Choices: Protective Gear

- Five video views (rider's face, forward, rear, left, right)
- Video review to characterize rider clothing
  - Torso clothing / apparel
  - Helmet
  - Gloves
  - Eyewear
- Reductionist coded conditions that existed for most of the trip


Percentage of Trips Including Each Clothing Type
Percentage of Trips
40%
35%
30%
25%
20%
15%
10%
5%
0%
Full Jacket Zipped, Non-leather
Full Jacket Zipped, Leather
Shirt, Short-sleeved or Tank
Shirt, Long-sleeved
Partial Jacket/Vest Zipped, Leather
Partial Jacket/Vest Zipped, Non-leather
Full Jacket Unzipped, Leather
Unknown
Other Categories
Clothing (Torso) Type


Percentage of Participants Observed Wearing Each Clothing Type
Percentage of Participants
80%
70%
60%
50%
40%
30%
20%
10%
0%
Full Jacket Zipped, Non-leather
Full Jacket Zipped, Leather
Shirt, Short-sleeved or Tank
Shirt, Long-sleeved
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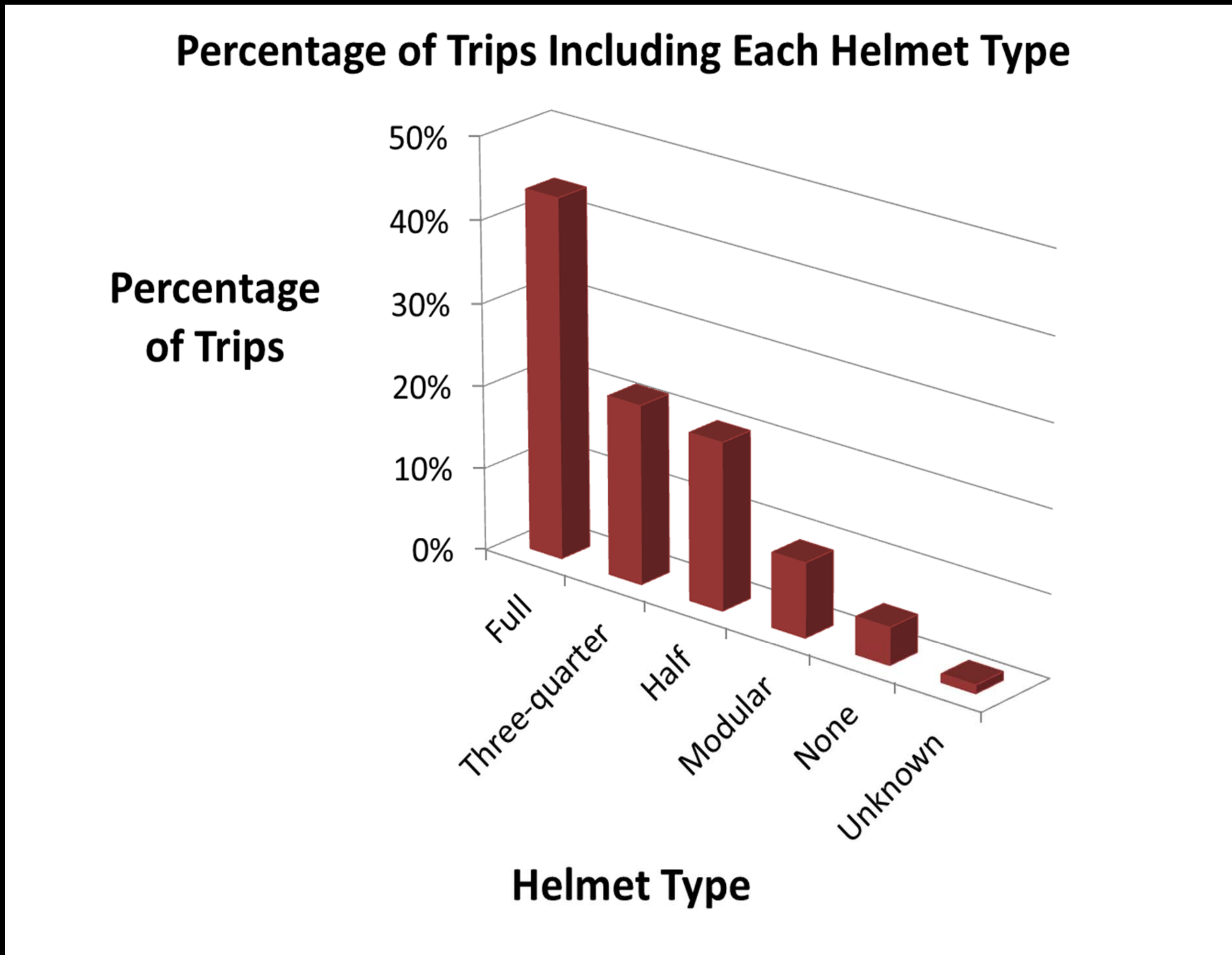
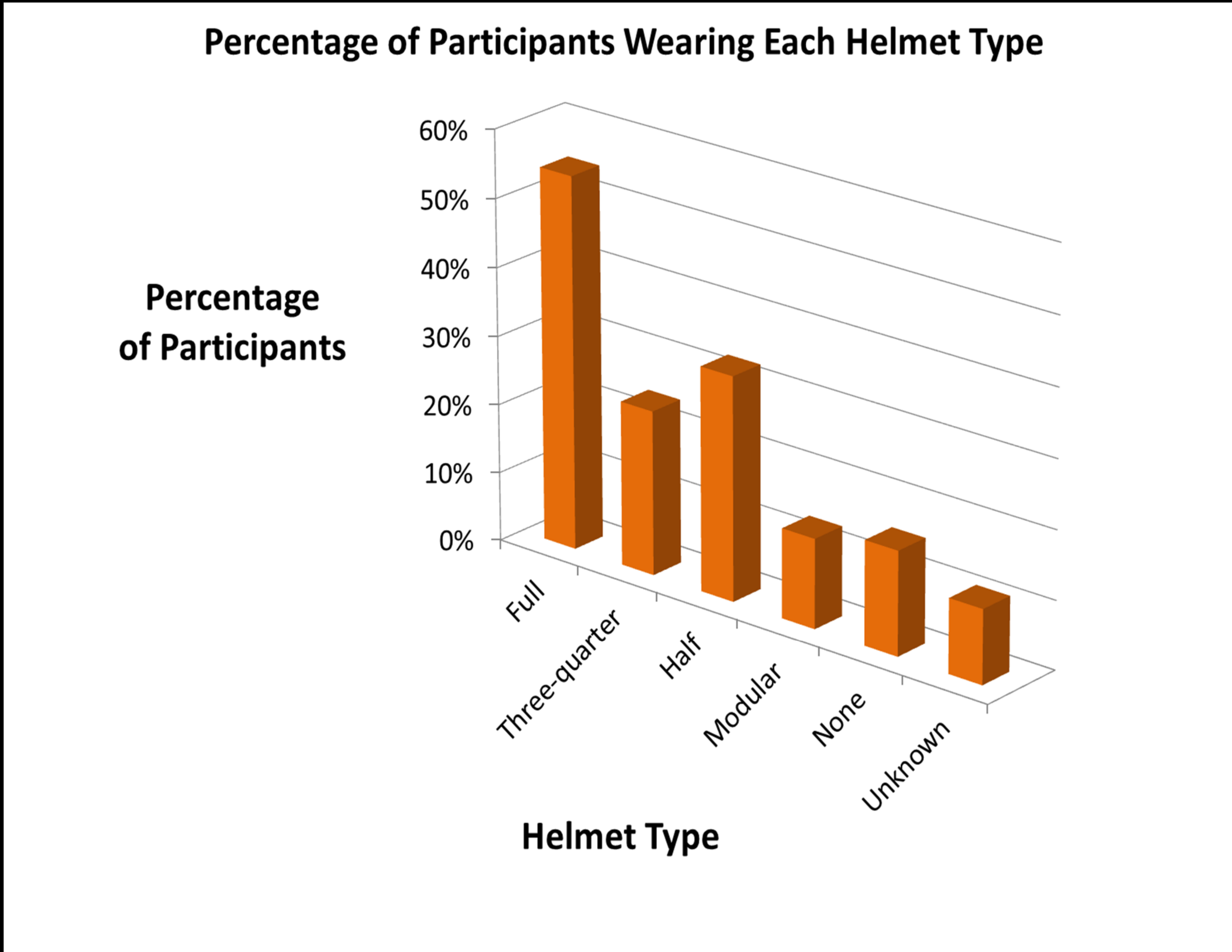

Percentage of Trips Including Each Helmet Type
Percentage of Trips
50%
40%
30%
20%
10%
0%
Full
Three-quarter
Half
Modular
None
Unknown
Helmet Type


Percentage of Participants Wearing Each Helmet Type
Percentage of Participants
60%
50%
40%
30%
20%
10%
0%
Full
Three-quarter
Half
Modular
None
Unknown
Helmet Type

Protective Gear Choices are Fluid

- Wide variation in torso clothing
  - 93% of riders at some point wore full zipped jackets
  - 67% at some point wore short-sleeved shirts or tank tops

Promising Practices

- Helmet usage, even in states with no helmet law, was common
  - 78% of participants always wore helmets; no participant was always without a helmet
  - Only 4 out of the 10 riders based in states with no helmet law were observed at some point without a helmet
  - Could be sample bias

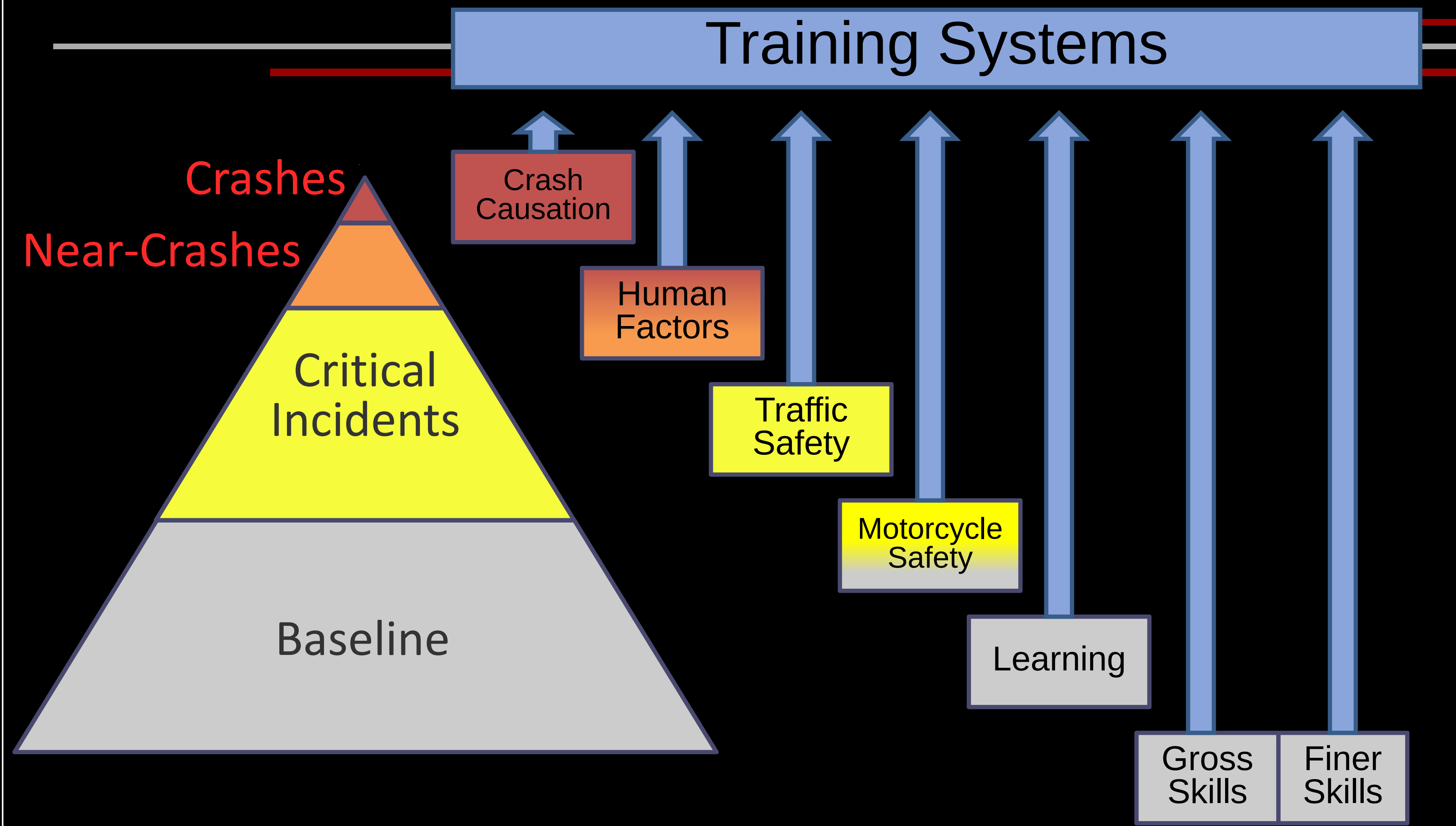
Baseline: Intersection Glance Behavior

- Looking forward
  - Riders look forward the majority of the time
  - All traversals include time looking forward
  - 85% of time through the intersection was spent looking forward
- Looking to the sides (duration .87 sec)
  - 51% of intersections show rider looking LEFT
  - 40% looking RIGHT
- Checking mirrors – 30%
- Looking behind - negligible

Summary

- Further analysis will tell us whether these choices resulted in overall safer or less safe riding outcomes.
- Complex data set requires layered approach
- Many more will be coming.
  - Over the next many years. e.g., The 100 Car Study was conducted in 2003/2004 and still being used to answer research questions.

Training Systems Development



Incidents: A Key to Human Factors

- Understanding loss of control sequence
- 23 crashes involving 19 riders
- 16 single vehicle
  - 15 were “tip overs” – slow speed, not underway
  - Only 1 single vehicle crash was at speed
- 7 other vehicles (OV) + study vehicle (SV)
  - 2 rear end
  - 4 OV turns into path of SV
  - 1 track-based crash

		speed		range		
Action	seconds	mph	kph	ft	m	TTC (s)
POV begins LTAP	112.784	41.6	66.9	214	65.1	3.7
POV brakes in lane	114.800	40.3	64.8	98	29.7	1.7
Rider lets go of left handlebar	116.388	33.6	54	20	6.1	0.6

- Left turning OV
- Pedestrian
- Well trained rider

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Action	seconds	mph	kph	ft	m	TTC (s)
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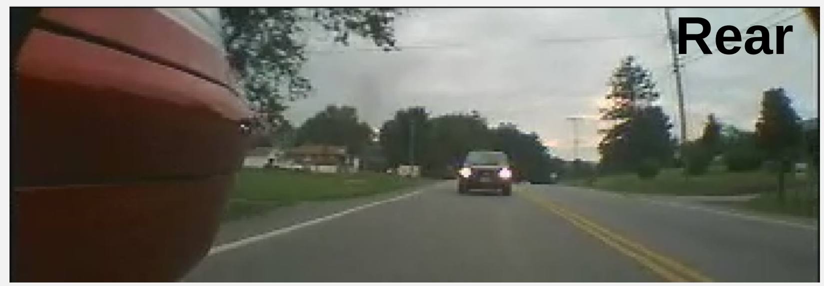
Rear-End Crash – Step by Step

			accel_x	speed		range			
Action	seconds		g	mph	kph	ft	m	TTC (s)	HDW (s)
LV 0.2g braking starts	304.510	0.000	-0.064	24.27	39	110	33.4	-33.4	3.1
Gaze returns forward last time	307.647	3.137	-0.099	26.39	42.41	88	26.7	5.3	2.3
SV decel starts	308.982	1.335	-0.061	26.39	42.41	59	18.1	2.6	1.5
Max SV decel (-0.52g)	309.850	0.868	-0.520	26.03	41.83	42	12.8	2.0	1.1
Impact from following vehicle	312.120	2.270	0.548	11.65	18.72	19	5.7	9.6	1.1
Peak accel from impact	312.320	0.200	1.041	11.65	18.72	19	5.9	3.3	1.1



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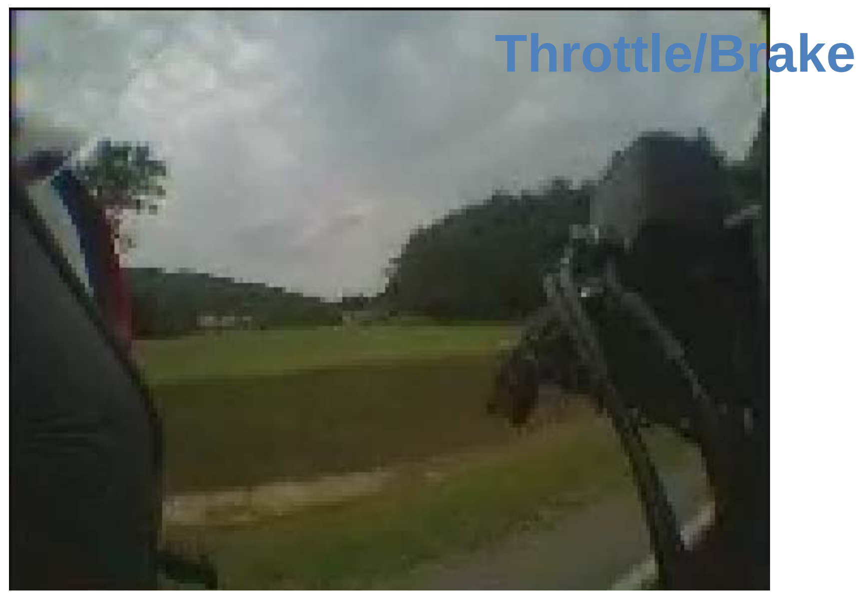

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Questions?

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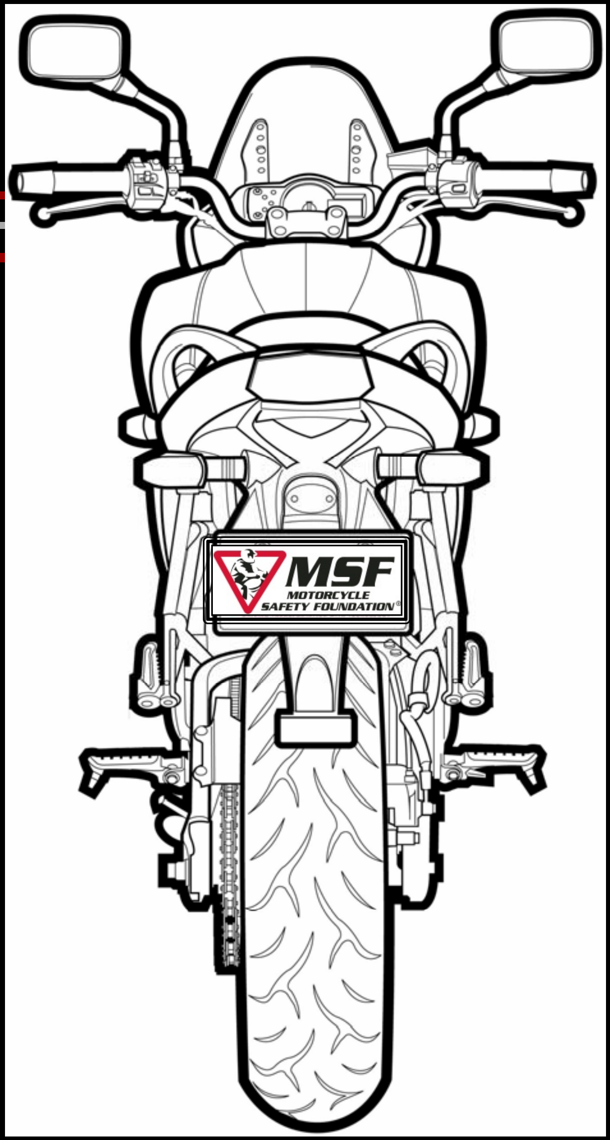

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