Visibility Effects on Driver Performance

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Final Presentation
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Project Motivation

- Problem :
  - In 20 years, one in five Americans will be older than 65.
  - As a group, the over 65 drivers have a higher crash rate than any other age group.
  - One reason suggested for the discrepancy is poorer vision and slower reaction time in older drivers.

Project Goal :

  - Assess the role that visibility range plays in driver performance.

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Added slower reaction time

Hypothesis, Objectives, Success Criteria

- Hypothesis:
  Differences of 200 feet in long range vision affects driver braking response distance by 10%.

- Objective:
  Evaluate through simulations in the MIT Age Lab Driving Simulator:
  a) Which long range vision differences (1000 vs. 800 feet, 800 vs. 600 feet, or 600 vs. 400 feet) are significant
  b) Whether the 200 foot differences are enough to cause a 10% difference in a driver's braking response distance.

- Success Criterion:
  Determine, with a confidence level of at least 90%, whether there is a 75% probability that a driver's braking response distance will be increased by 10% or more, if the driver's long range vision capability is increased by 200 feet.

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Updated: check that increases in success criteria is correct word and that updates HOS makes sense.

Experimental Process

- 35 Subjects Tested for 30 minutes:
  - Lost 5 Subjects
  - Subjects given pre- and post- questionnaires
- Four Distances Tested: (400, 600, 800, 1000 ft)
  - Pedestrian and a stopped Vehicle
- Events Randomized by Method of Latin Squares:
  - Every subject did every event exactly once
  - 4 distances, 2 events per distance made for 8 events
- Measurements Taken
  - Recorded the driver's behavior (i.e. speed, brake and accelerator depression) and the distances events occurred
  - Extracted the distance from an event when the driver began to brake

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Make this what we did and what measurements we took. Add a graphic to explain what braking response distance is…

Subject Testing

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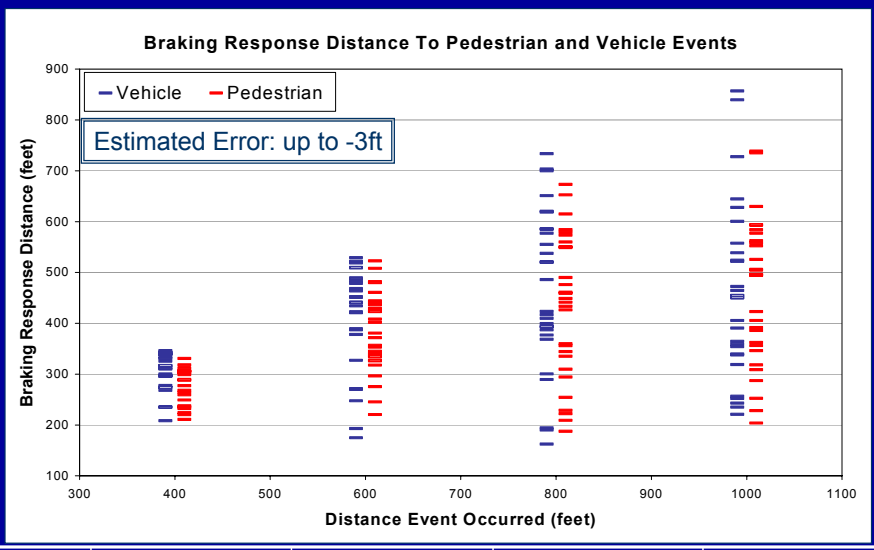
List out problems encountered – insert picture of age lab with testing subject

Results



	400 Feet	600 Feet	800 Feet	1000 Feet
Pedestrian	Mean:272 SD:33	Mean:380 SD:78	Mean:434 SD:144	Mean:476 SD:138
Vehicle	Mean:306 SD:36	Mean:418 SD:105	Mean:474 SD:157	Mean:465 SD:171

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Results: overall graphic depicting all results – need to add error bars – explain people who were thrown out…

Analysis Overview

- **Step 1: Extract Driver Braking Response Distance:**
  - Result: Extracted the distance from the event when the driver first began to brake
- **Step 2: Data Refinement:**
  - Result: 30 subjects tested/27 subjects with useful data
- **Step 3: Combine Data?**
  - Result: 1) Braking response to pedestrian and vehicle statistically different at 400 and 600 feet
  - Result: 2) Data analysis was performed separately for pedestrian and vehicle event responses
- **Step 4: Carry out Objective: Determined which vision differences are most significant with T-Tests:**
  - Result: If t-test p value is less than .05 (5% significance) the two distances are statistically different

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1. Each driver had data file containing distance down the road events occurred, and continuous recording of brake depression and distance traveled.
2. Some driver's did not behave like "normal" drivers-they did not stop or brake for obstacles.
3. Performed paired t-test on braking distance response data for pedestrian and vehicle to determine whether the driver's responses to the events were statistically different.
4. Performed paired t-tests on response data for each of the 200 foot differences to determine which distances caused a statistically different driver braking response. Analysis for vehicle and pedestrian performed separately.

Analysis Overview, Continued

Distance:	Event:	T-test P value:	Significance?
400 vs. 600ft	Pedestrian	4.93E-07	Different
	Vehicle	8.30E-06	Different
600 vs. 800ft	Pedestrian	0.02897	Different
	Vehicle	0.01393	Different
800 vs. 1000ft	Pedestrian	0.16677	Same
	Vehicle	0.77248	Same
400 vs. 800ft	Pedestrian	1.05E-05	Different
	Vehicle	6.08E-06	Different
400 vs. 1000ft	Pedestrian	2.57E-07	Different
	Vehicle	7.09E-05	Different
600 vs. 800ft	Pedestrian	5.99E-04	Different
	Vehicle	0.14168	Same

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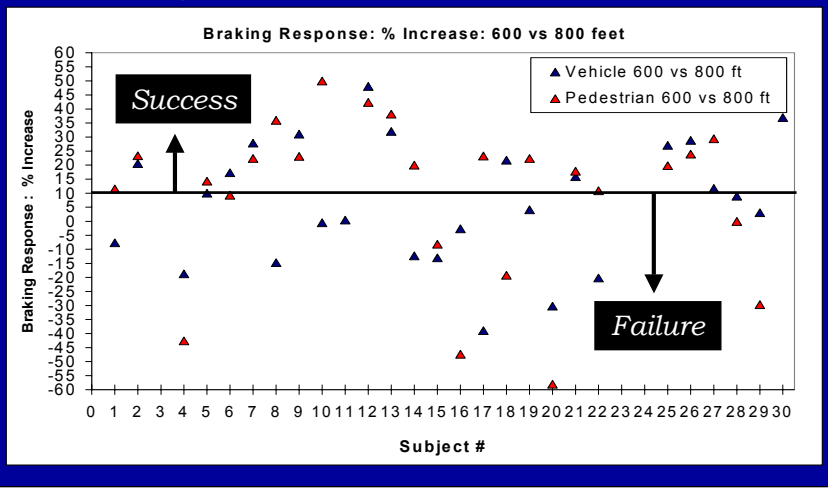
Evaluation of Objectives and Success Criteria

Analysis Overview, Continued

- **Step 5: Evaluated Success Criteria: Probability of Results and Confidence Level:**
  - Success: Braking response distance increased by 10% with an increase of 200 feet in long range vision.
  - Failure: Braking response distance decreased, or was not increased by 10%



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Evaluation of Objectives and Success Criteria

Analysis Overview, Continued

- Result: Used a nomograph relating sample size to the number of failures to determine the reliability and the confidence level of our results.
  - Sample size for all comparisons was 54.

Distance:	# Success's	# Failure's	If 90 % Confident, Reliability is:	If 75 % Reliable, Confidence is:
400 vs. 600ft	41	13	68%	56%
600 vs. 800ft	39	15	65%	36%
800 vs. 1000ft	24	30	< 50% (off scale)	0%

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Evaluation of Objectives and Success Criteria

Implications of Results

- **Difference between Vehicle and Pedestrian Events:**
  - Vehicle and Pedestrian events are too different to analyze together.
  - An experiment redesign would need to focus on one single event (pedestrian).
  - The vehicle event did not behave as well as pedestrian event possibly because of the driver confusion over the behavior of the parked vehicle in the road.
- **Minimum stopping distance same for all intervals:**
  - For all tests, the minimum values of braking distance were around 200 feet
- **Greater differences in braking distance for closer events:**
  - Braking distance difference decreased as event distance increased.
- **Subject number not high enough for desired confidence level and reliability:**
  - Best confidence and reliability for 400-600 foot test, and decrease with increasing distance of event.
  - In order to achieve the desired confidence and reliability, we would only be allowed 6/54 failures, so more subjects needed

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Explain what other research we may want to do…

What's Next?

- **Final Report**
  - All data analysis is completed
- **Future Implications for MIT Age Lab**
  - MIT Age Lab interested in broadening experiment to look at the effects on older drivers
- **Proposed Experiment Changes for Future Experiments**
  - Use only pedestrian event
  - Use larger subject pool
  - Further restrict the driver speed
  - Look at intermediate distances as well
- **Problems with the vehicle event lead to simulator function changes**
  - Bryan Reimer at the MIT Age lab wrote a new function to change the parked vehicle from taking off based on the approach speed rather than closing time.
  - The new function requires drivers to properly stop before simulation can continue.

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Explain what other research we may want to do…

Acknowledgements

- Professor Willcox
- Dr. Bryan Reimer and the MIT Age Lab
- Dr. Thomas Jarchow
- The 16.62x Faculty and Staff
- Professor L. Young

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Back-Up Slides

Expenses

Item	Cost
Disks for Data	$7
Subject Incentives: Food and Drink	$75
TOTAL	$82

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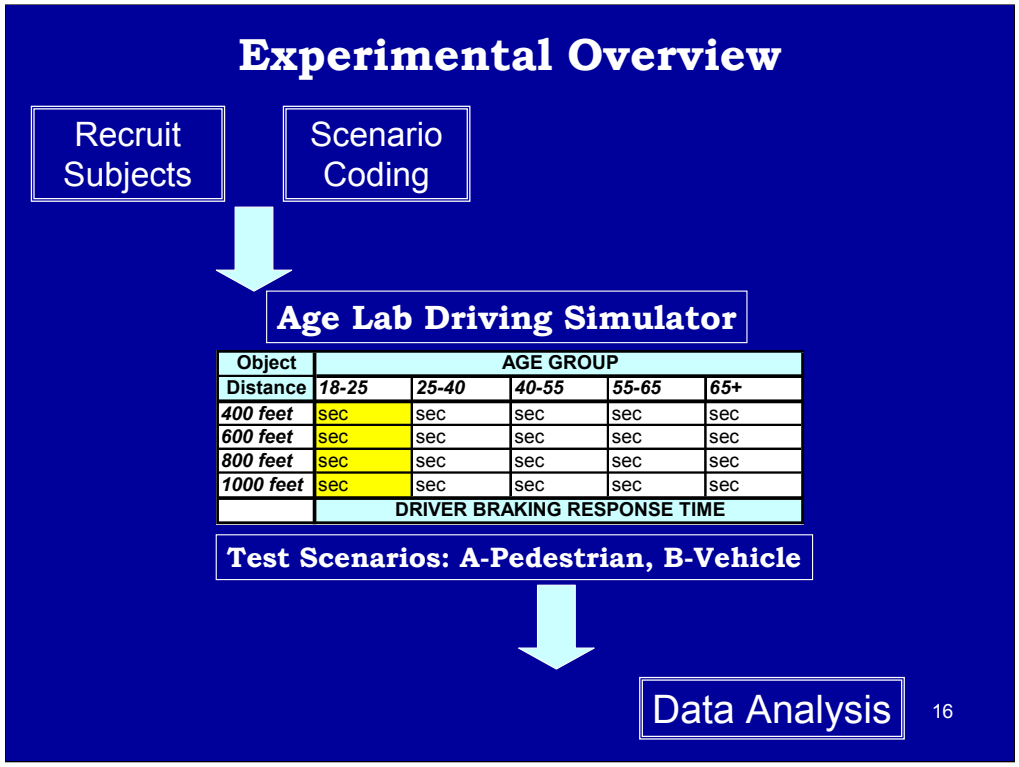
Do we need to summarize what we spent?



Should we keep this one? Not necessary I don't think… Need to double check whether Age Lab wants to continue with this experiment…

Experimental Design

S1	S2	S3	S4	S5	S6	S7	S8
1	2	3	4	5	6	7	8
6	7	8	1	2	3	4	5
3	4	5	6	7	8	1	2
5	6	7	8	1	2	3	4
7	8	1	2	3	4	5	6
2	3	4	5	6	7	8	1
4	5	6	7	8	1	2	3
8	1	2	3	4	5	6	7

S1-S8: Subject perform experiment in corresponding column

1-8: Events performed by the subject (Two at each of four distances)

Method of Latin Squares for Randomizing Events

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Should we include this? Back-up slide…

Errors

- Measurable Errors
  - There is a possible .04 second discrepancy between data extracted and driver braking (Simulator records at 60 Hz)
  - .04 seconds corresponds to 3 feet at 55 mph
- Immeasurable Errors
  - Differences in Pre-test brief given to subjects
  - Differences in test conditions (early morning vs. late night, etc.)
  - Simulator Sickness
  - Simulator vs. Reality

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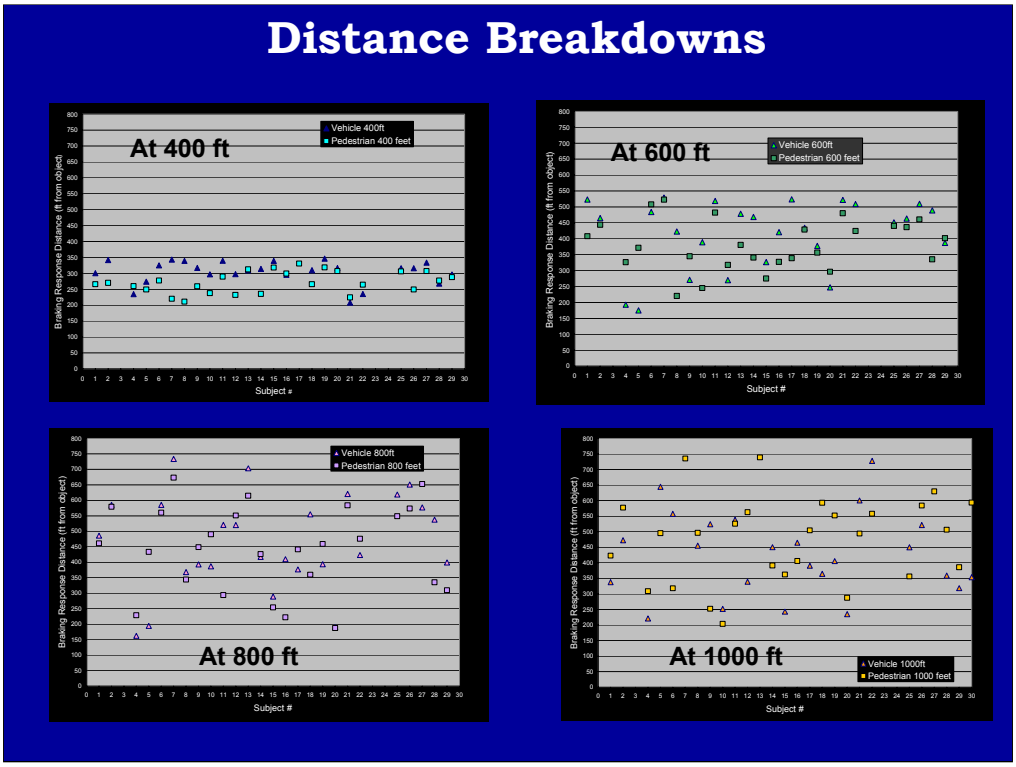
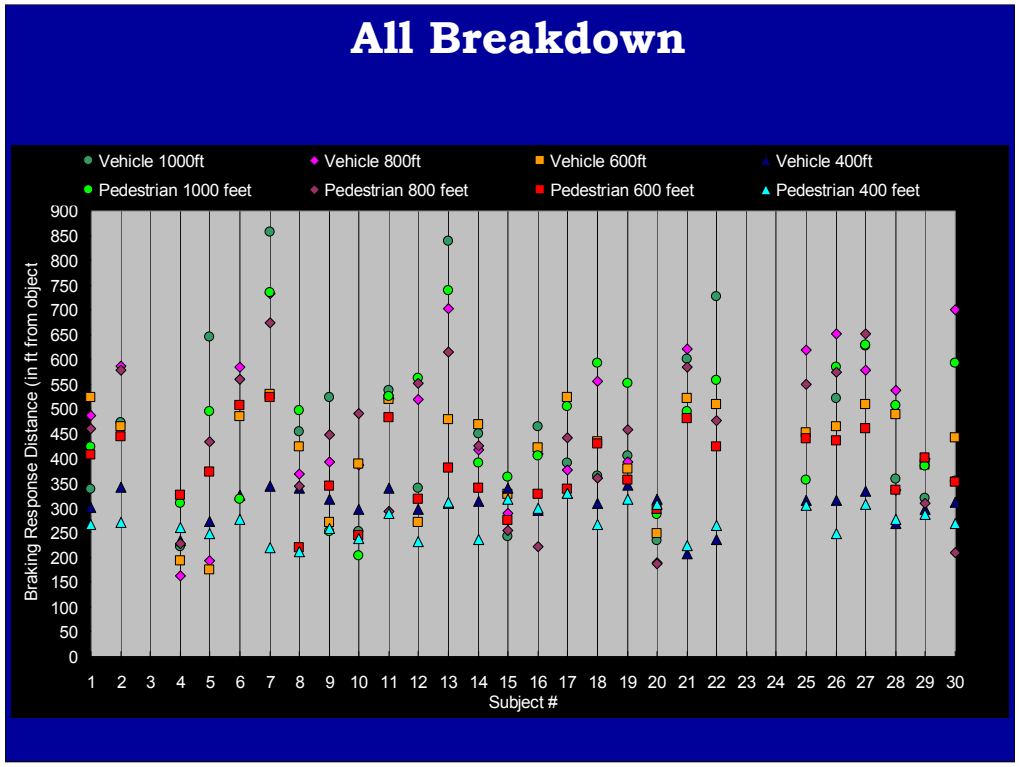
The following are graphs not included in the presentation, but pertinent to the experiment.



Results: overall graphic depicting all results – need to add error bars – explain people who were thrown out…



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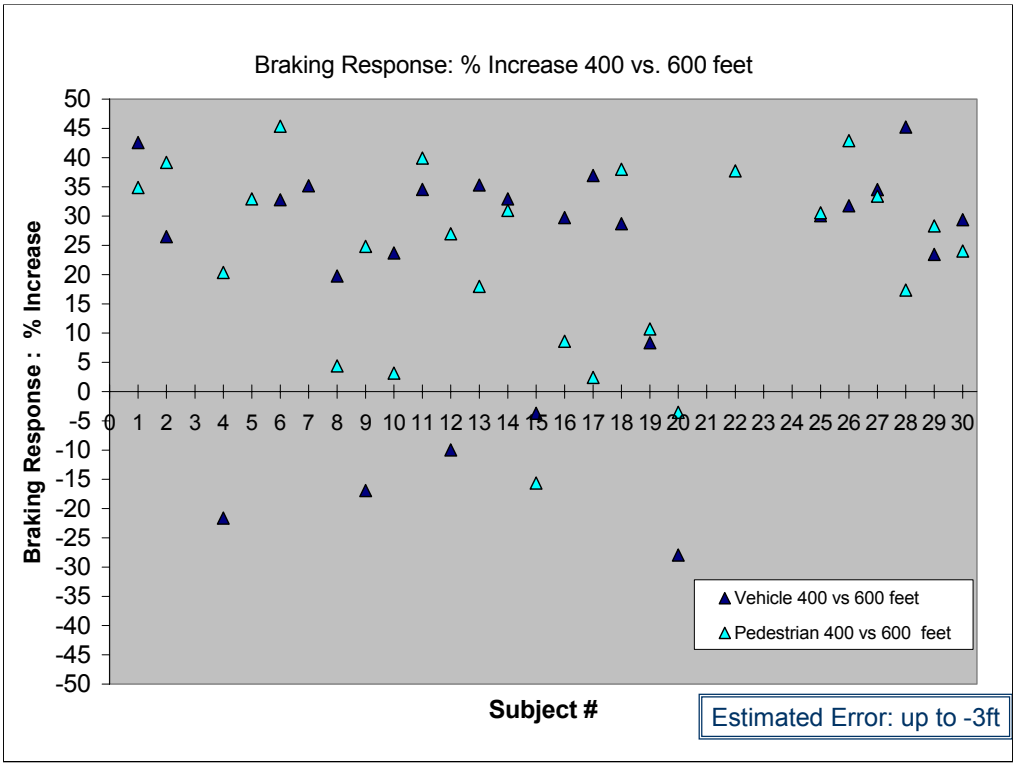

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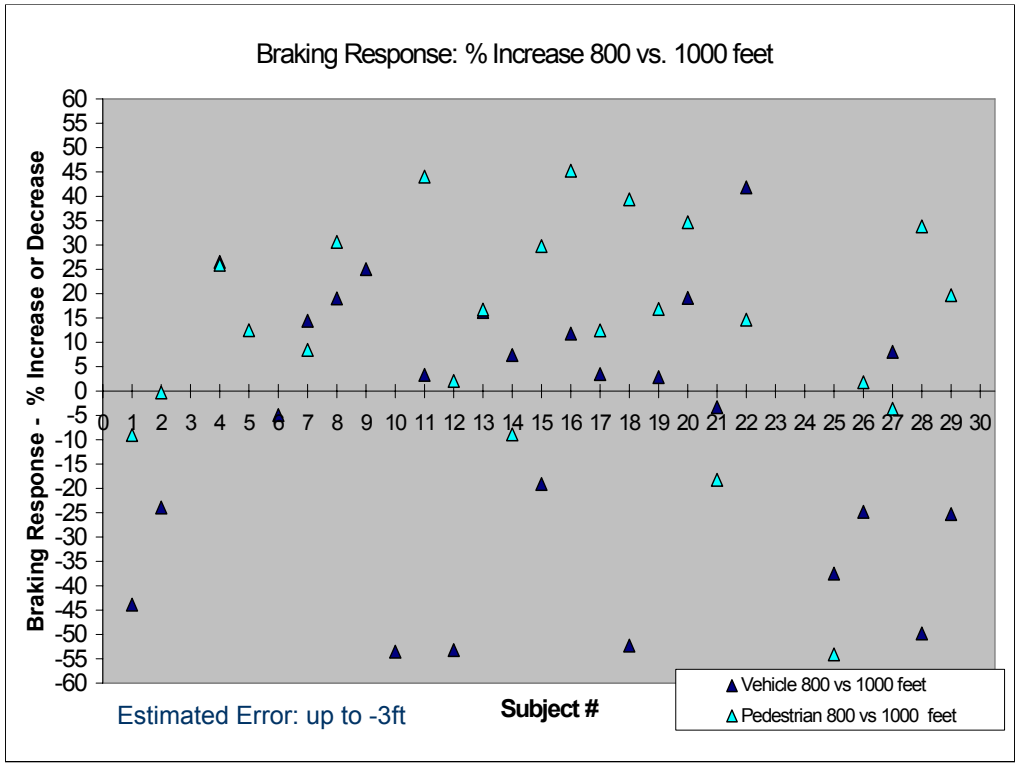
Braking Response: % Increase 800 vs. 1000 feet
Braking Response - % Increase or Decrease
60
55
50
45
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Subject #
Vehicle 800 vs 1000 feet
Pedestrian 800 vs 1000 feet
Estimated Error: up to -3ft