



Bat Speed – Part 1

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January 14th, 2008



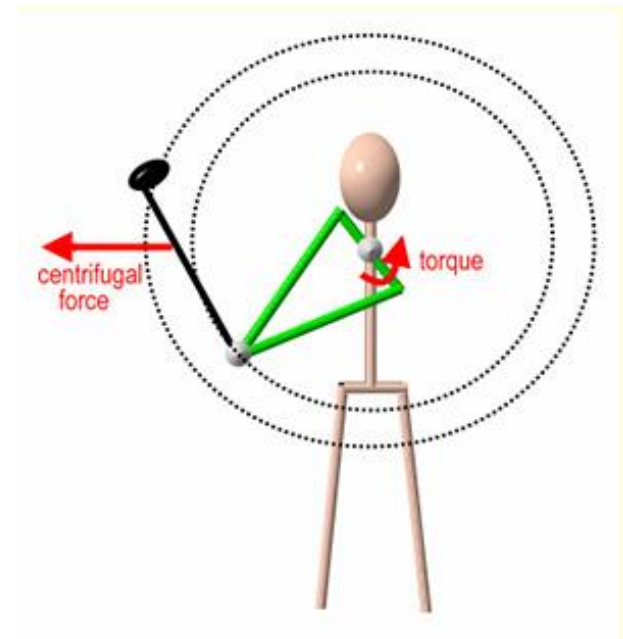


Background

- Objective of hitting is to hit the ball hard – this increases the chance of getting on base
- Velocity of batted ball is determined by
 - Speed of pitch
 - Weight of the ball
 - ‘Rebound’ of ball off bat
 - Weight of the bat
 - Speed of bat when it hits the ball
- For any swing at a given pitch, both the weight and rebound of the ball, and the weight of the bat are the same
- Therefore, the speed of the batter’s swing will determine how hard he will hit the ball

Pendulum Models of Baseball Swings

- The best way to get fast bat speed is to rotate the bat quickly around your body, using your hips to turn your shoulders
- This motion is like a pendulum
- Single pendulum model
 - Arms and wrist stiff
- Double pendulum model
 - Arms straight, wrists can bend
- Triple pendulum model
 - Arms and wrists bend



A Double Pendulum Model
(for a Golf Swing)

Green = Arms; Black = Bat

A Double Pendulum Batting Swing (Top View)

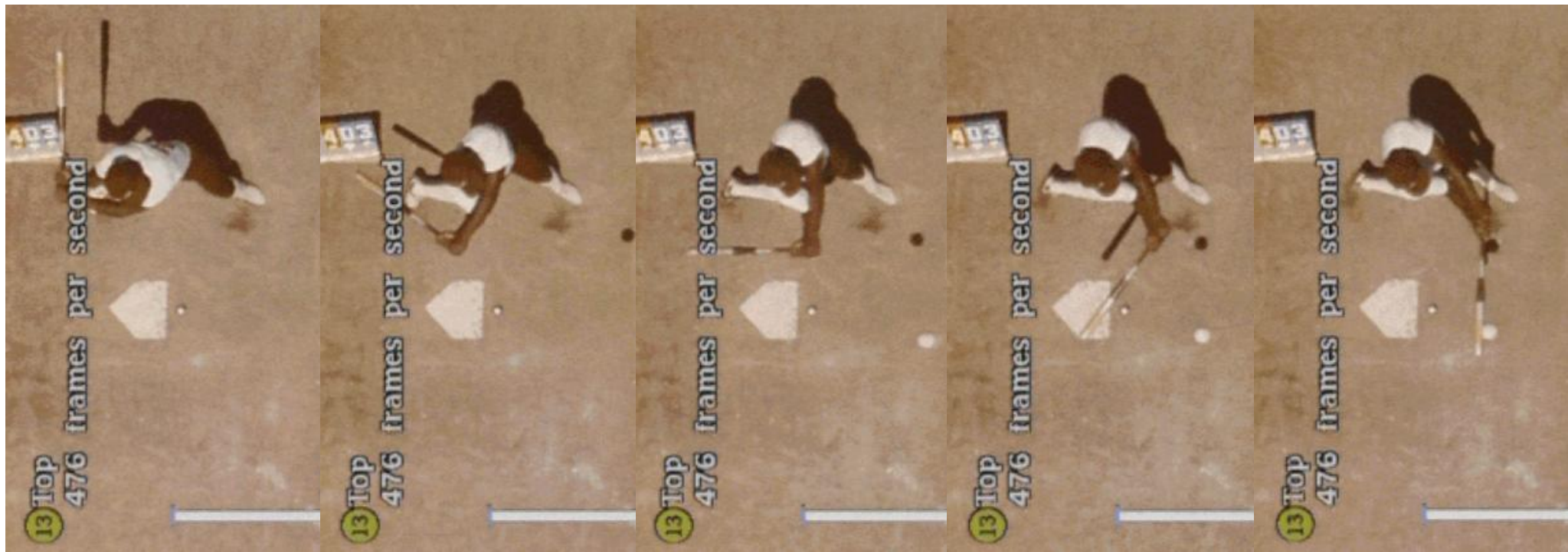
1

2

3

4

5



← Direction of Pitch



Question and Hypothesis

■ Question

- What type of swing (single, double, or triple pendulum type) will produce the highest bat speed?

■ Hypothesis

- A triple pendulum will produce the highest bat speed.

■ Secondary question

- Will different bats result in different bat speeds with the same type of swing

■ Secondary hypothesis

- Lighter bats will produce higher bat speeds with the same swing type



Procedures

- Build test apparatus
 - Connect aluminum pieces to model arm, forearm, and wrists with bolts for 'joints' (oiled to minimize friction). Make size of arms like a typical 11 year old batter. Use a real baseball bat attached to aluminum clamp at 'wrists'.
 - Use bolts and/or clamps to lock arms in place to simulate single and double pendulum swings.
 - Use a bungee cord affixed to arms and wrapped around 'shoulder' pivot bolt to initiate motion downward.
 - Position a swing speed radar to measure maximum bat speed.
- Test bat swings with single, double, and triple pendulum swings
 - Adjust start position of bat and arms to realistic position.
 - Adjust bungee cord to give consistent acceleration to each swing.
 - Measure speed for 10 trials using radar and record data.
- Try different bats using optimal swing type to see how this might change bat speed.
- Video tape one trial to show what happened, and capture individual frames for analysis.
- Analyze and graph results in MS excel.

Bat speed Apparatus Setup

■ Relaxed position



■ Loaded position





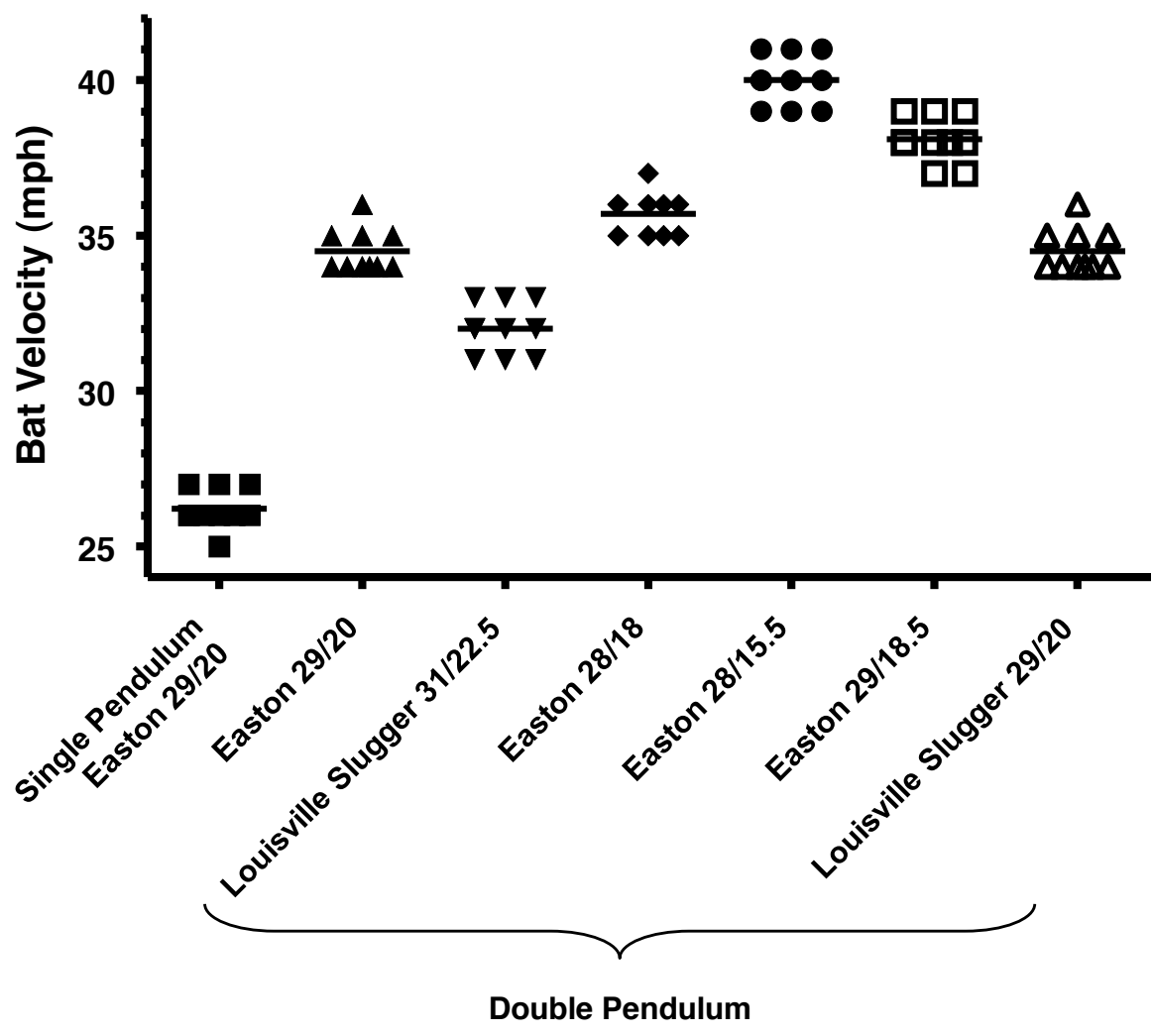
Conditions Measured

Condition	Pendulum Type	Bat			Description
		Length (in.)	Weight (oz.)	Barrel (in.)	
2	Double	29	20	2 3/4	Easton 29/20
3	Double	31	22.5	2 3/4	Louisville Slugger 31/22.5
4	Double	28	18	2 5/8	Easton 28/18
5	Double	28	15.5	2 1/4	Easton 28/15.5
6	Double	29	18.5	2 1/4	Easton 29/18.5
7	Double	29	20	2 3/4	Louisville Slugger 29/20

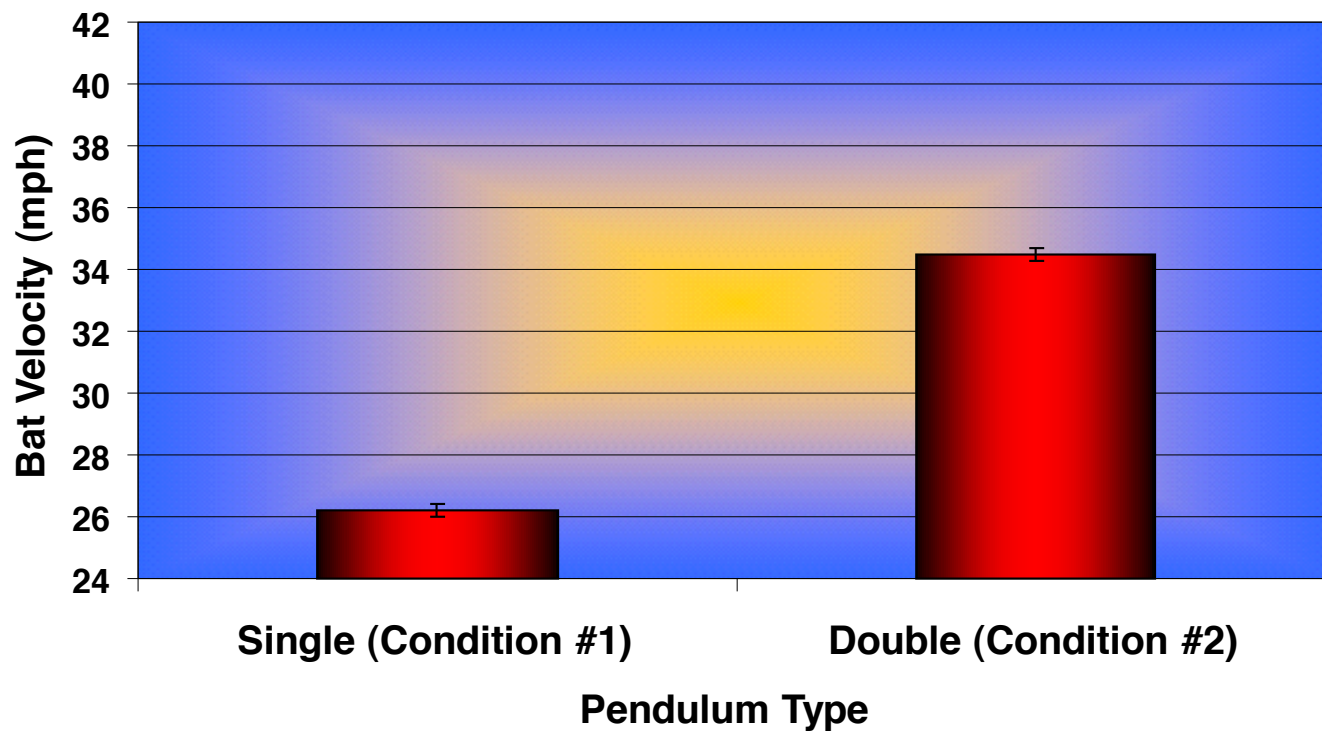
- 10 trials were conducted with each condition, and bat speed recorded
- Note: The triple pendulum design failed. I observed a 'bounce' of the bat back onto arms which is not like a real swing. This was probably because there was no force applied to the wrists (like a real batter would use).



Scatter Plot of All Data



A Double Pendulum Swing is Faster Than a Single Pendulum Swing



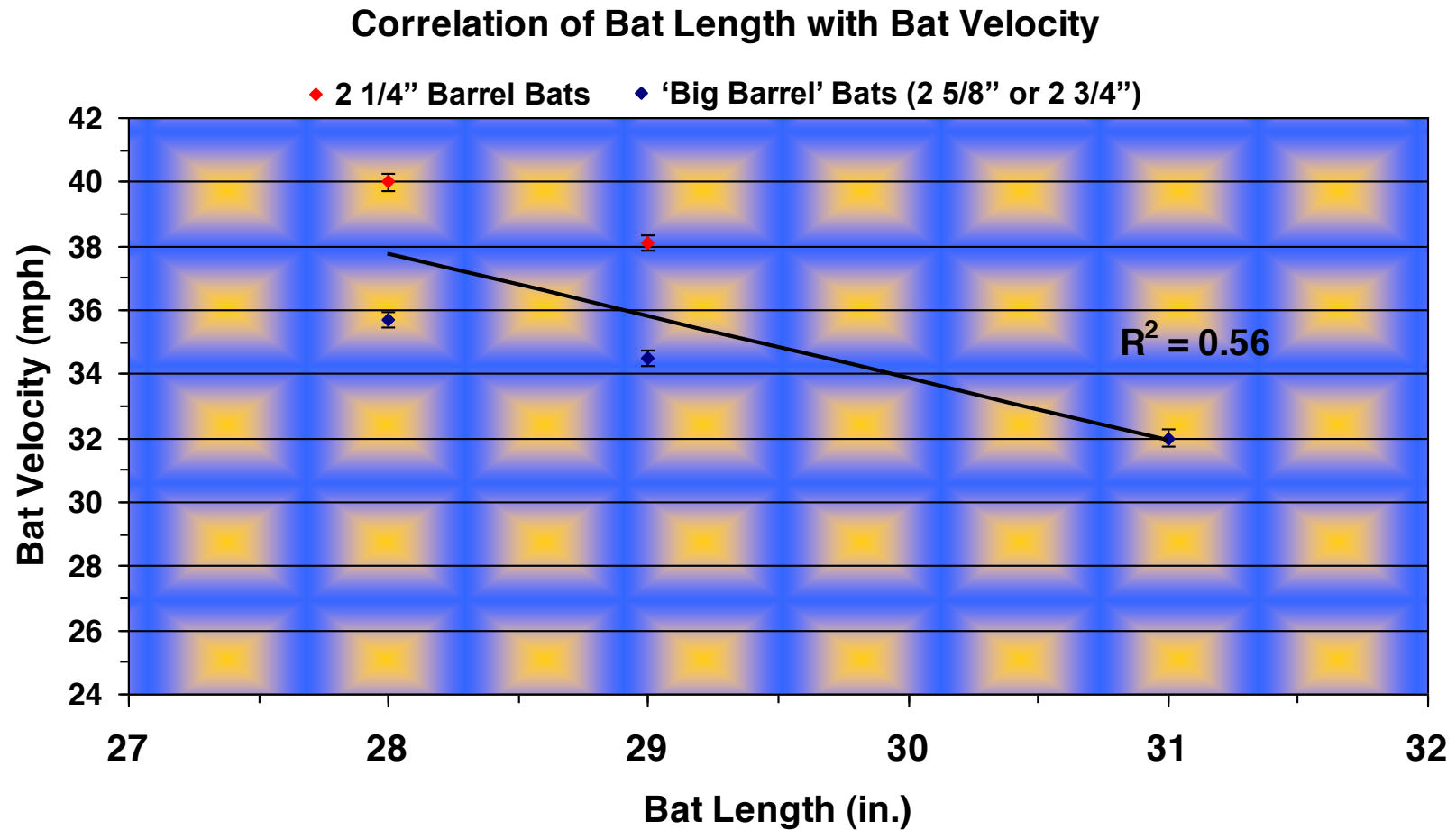
Increase in bat speed
with double pendulum

32%

p-value (t-test)

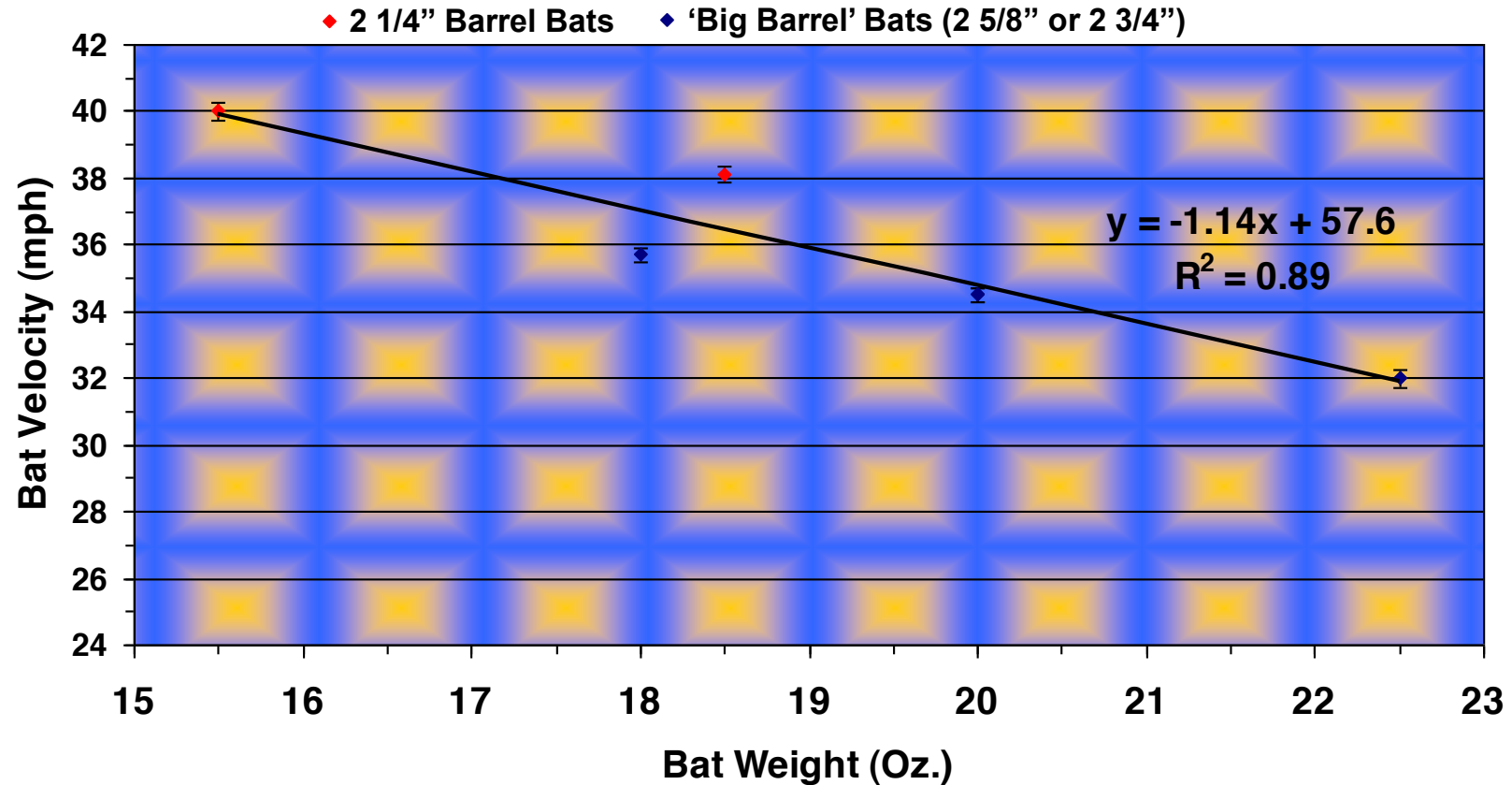
< 0.0001

Bat Length Does Not Effect Bat Speed



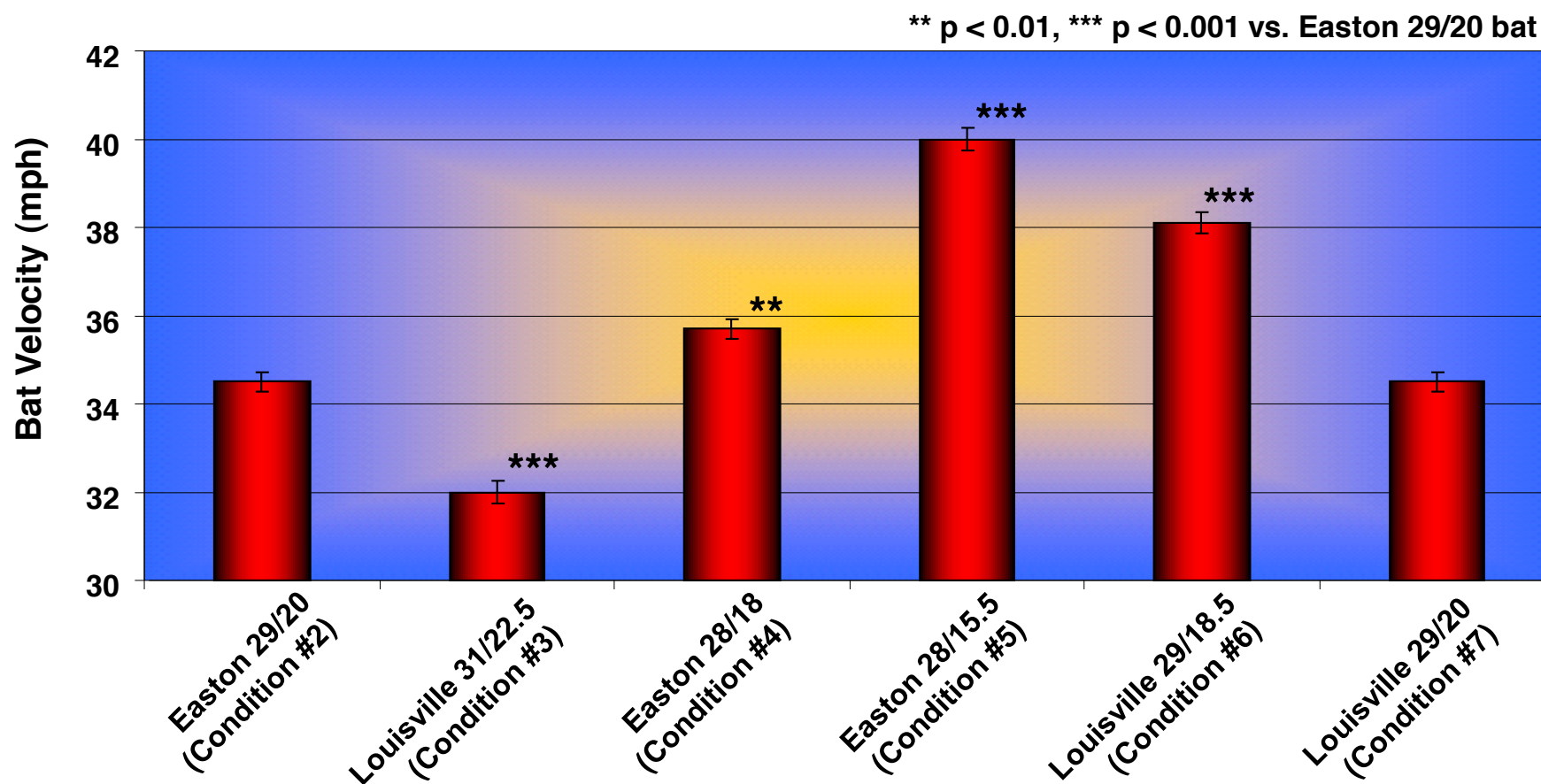
Lighter Bats Produce Faster Swings

Correlation of Bat Weight with Bat Velocity



- Single exception is 28/18 'big barrel' was slower than 29/18.5 normal barrel
 - Increased air resistance?
 - Different distribution of weight ?
- Further research required to identify if this is real, and if so, why.

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Conclusions – Part 1



- Baseball swings can be modeled with pendulums.
- A double pendulum swing produces higher bat speed than a single pendulum.
- Lighter bats tend to produce higher bat speeds than heavier ones.
- Big barrel bats might produce lower speeds than regular barrel bats, however more data is needed to show this