Kick-inetic Energy: The Physics of Karate

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Purpose

As a karate student, I want to know which kick gives me the best chance of winning a tournament. My Sensei says I am best at rear snap, side thrust, and rear roundhouse. In a match, choosing the right technique is the difference between a weak move and a scoring point. I feel like my rear roundhouse is my strongest kick, so my goal is to use physics and the scientific method to prove if that is true or if one of the other kicks is more powerful!

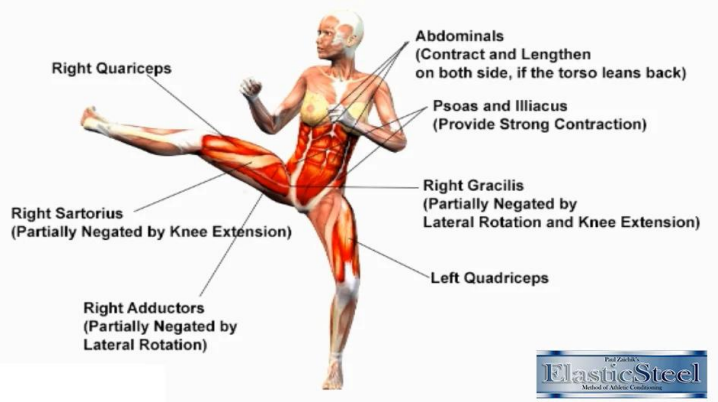
Hypothesis

I predict that the rear roundhouse will have the most strength by moving the kicking bag the furthest distance. I believe this will happen because the roundhouse uses more hip rotation and a longer lever arm than the snap or thrust kicks which should create more force.

Research

The Leg Is a Simple Machine

- **Legs are Levers:** My hip is the fulcrum (pivot), and my leg is the lever arm. This helps me swing my foot with a lot of force.
- **The Power of Torque:** My muscles create torque, which is a twisting force that gets my leg moving fast.
- **Speed Wins:** Since my foot is at the end of the lever, it travels the fastest and hits way harder than my thigh.



Potential and Kinetic Energy

- **Stored Energy:** Before the kick, I build up potential energy in my muscles, like a stretched rubber band.
- **Energy in Motion:** When I kick, that stored energy turns into kinetic energy.
- **Mass vs. Speed:** A heavier leg creates more impact, but speed is more important. In the math formula for energy ($KE = \frac{1}{2} mv^2$), the speed is squared.
- **Speed Wins:** Since speed is squared, doubling how fast I kick quadruples the power! This is why a fast, “snappy” kick so hard.

$$E_k = \frac{1}{2} mv^2$$

Kinetic Energy — mass — velocity

Experimental Method

Materials

Kicking bag	Tape
Tape measure	Camera on a tripod

Variables

Variable	Description
Independent variable	Type of kick: snap, roundhouse, thrust.
Dependent variable	How many inches the bag moves after impact.
Constants	The same kicking bag, the same kicker (me), the bag's air pressure, and starting the bag at the same spot every time.
Control	The bag when it is not kicked (a distance of zero inches).

Bag Stabilization

Control

Roundhouse

Type of Kicks

Snap

Thrust

Experimental Method

Set up the kicking bag and put the camera on a tripod.

1

Tape the tape measure to the wall so the camera can see how far the bag moves.

2

Get in my "ready stance" and prepare to begin kicking.

3

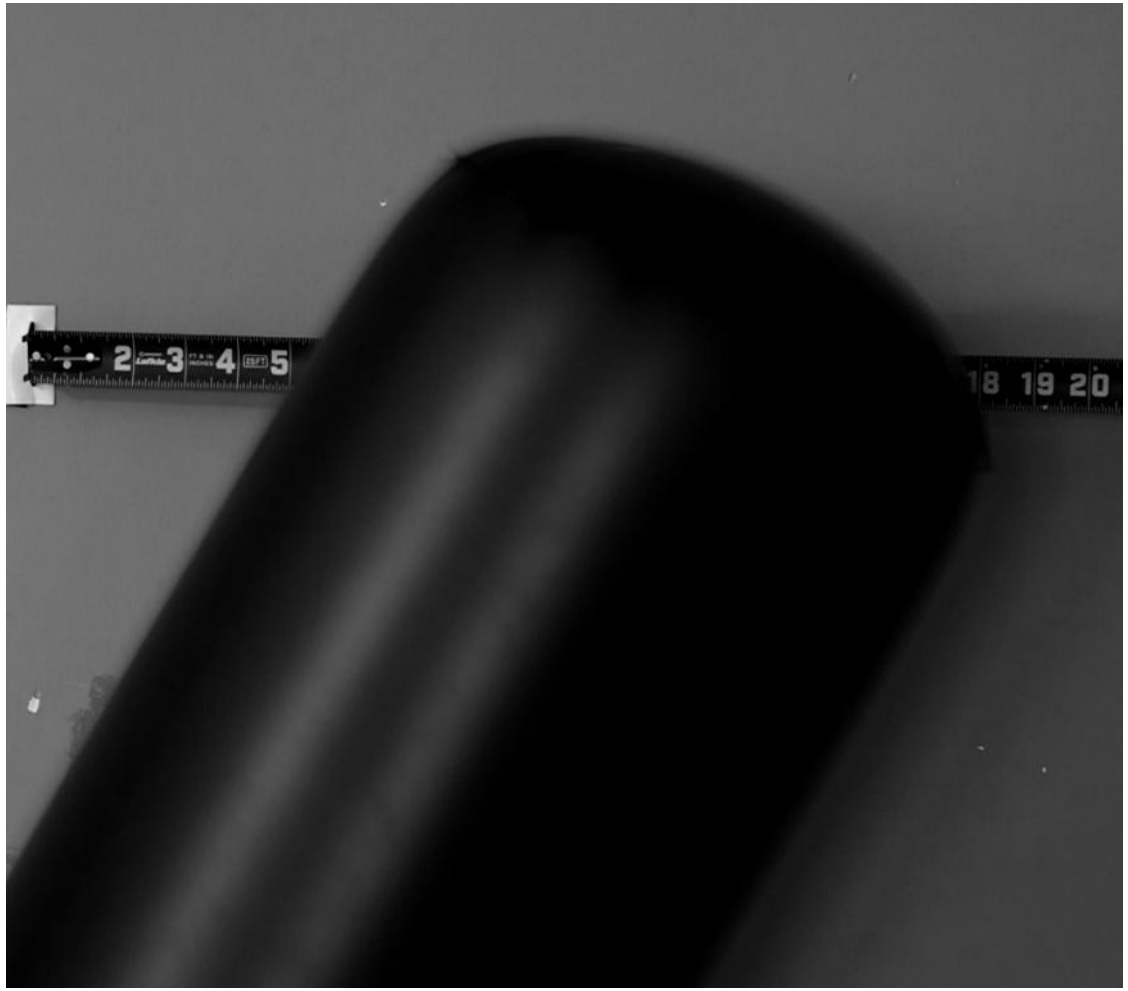
Kick the bag while the camera takes a video of the bag moving during each kick.

4

Watch the video in slow motion to see exactly how many inches the bag moved.

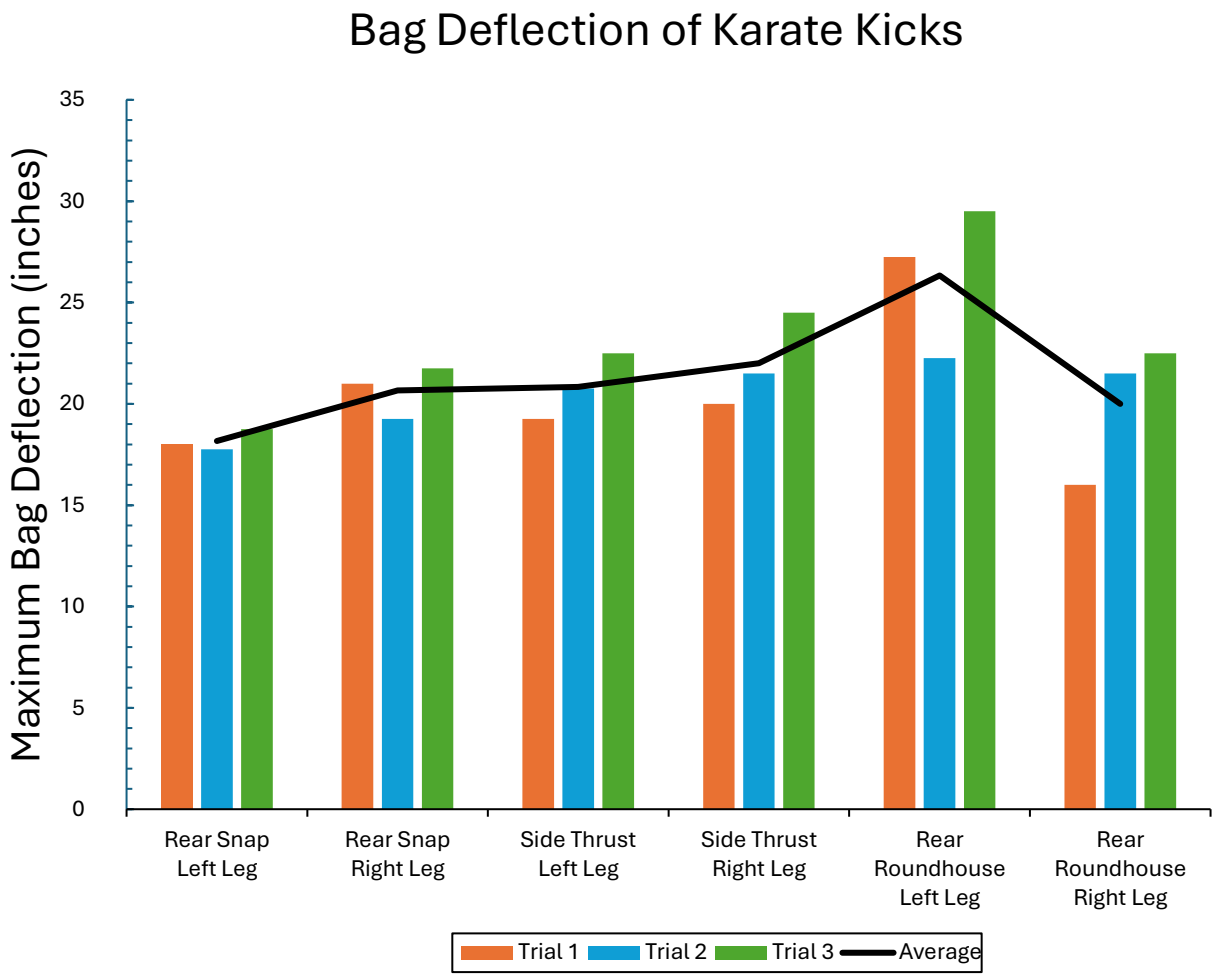
5

Repeat steps 2-5 for three trials of both legs for all three kicks.



Results

Kick	Maximum Bag Deflection (inches)			
	Trials			
	1	2	3	Average
Rear Snap: Left Leg	18	17 ¾	18 ¾	18.17
Rear Snap: Right Leg	21	19	21 ¾	20.67
Side Thrust: Left Leg	19 ¼	20 ¾	22 ½	20.83
Side Thrust: Right Leg	20	21 ½	24 ½	22.00
Roundhouse: Left Leg	27 ¼	22 ¼	29 ½	26.33
Roundhouse: Right Leg	16	21 ½	22 ½	20.00
All Left Kicks				21.78
All Right Kicks				20.89
Rear Snap: Both Legs				19.42
Side Thrust: Both Legs				21.42
Roundhouse: Both Legs				23.17



Conclusion

My hypothesis was correct! The rear roundhouse was my strongest kick, averaging 23.17 inches, while the side thrust averaged 21.42 inches and the rear snap averaged 19.42 inches. My results prove the roundhouse is most powerful because my leg acts like a long lever and my hips create torque, which together generate the most speed and impact.

Since I am left-footed, I was surprised that my right foot did better on the snap and thrust kicks, even though my left roundhouse was stronger than my right one. If I did this project again, I would test a larger group of people to see if these results stay the same for everyone or if they change based on personal factors.