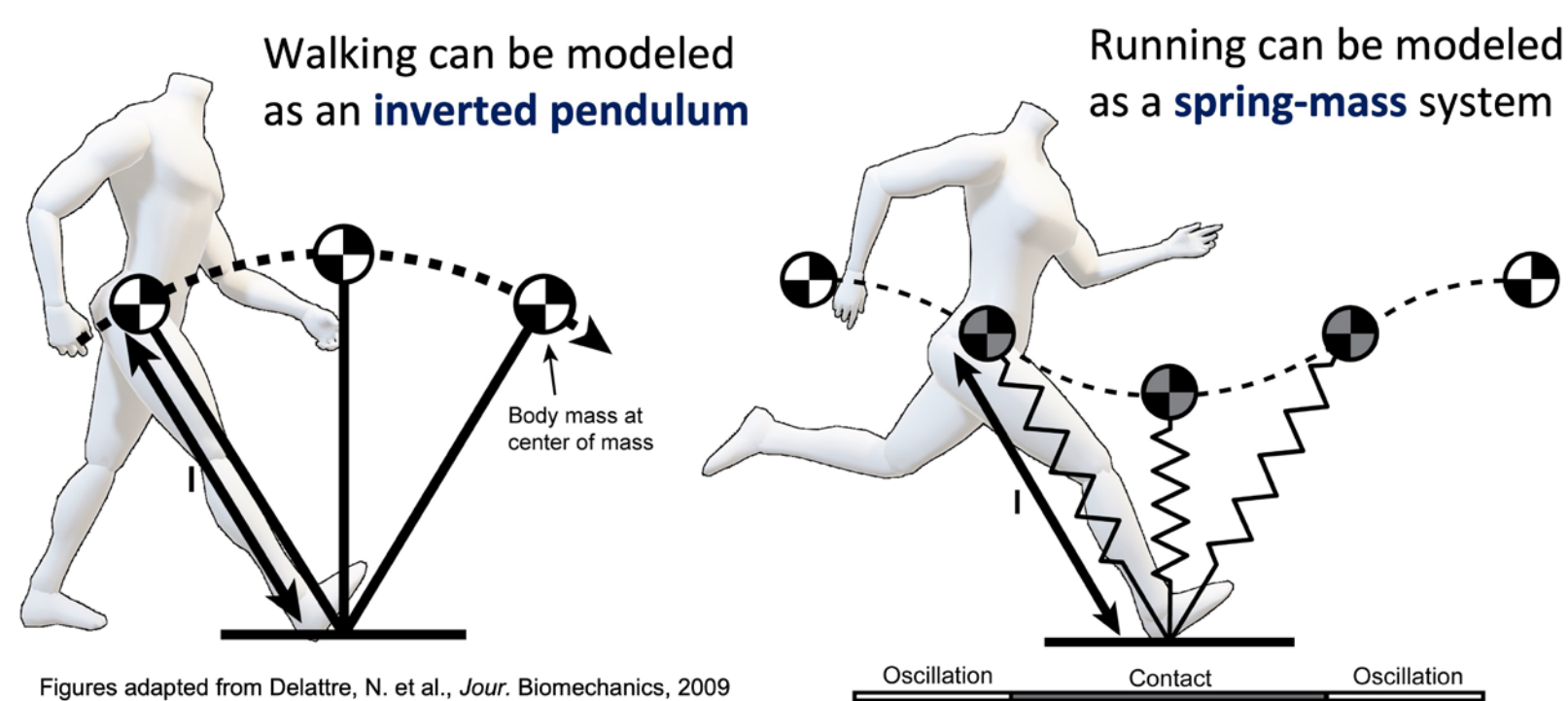# Cassandra Shriver

Chambers/Jones Award
Ph.D. Student, Quantitative Biosciences in Biological Sciences
Third Year ARCS Scholar

Georgia Tech

Hang in there: How do Non-Primate Mammals Climb?

Novel models suggest time scale limitations for how quickly non-primate mammals need to re-grab trees after letting go to avoid falling.

We use pendular dynamics in terrestrial locomotion

Walking can be modeled as an **inverted pendulum**

Body mass at center of mass

Running can be modeled as a **spring-mass** system

Oscillation   Contact   Oscillation

Figures adapted from Delattre, N. et al., *Jour. Biomechanics*, 2009

Climbing is a more challenging form of locomotion

Must Move Upwards:
- Always against gravity
- No restoring force pulling you back to the tree
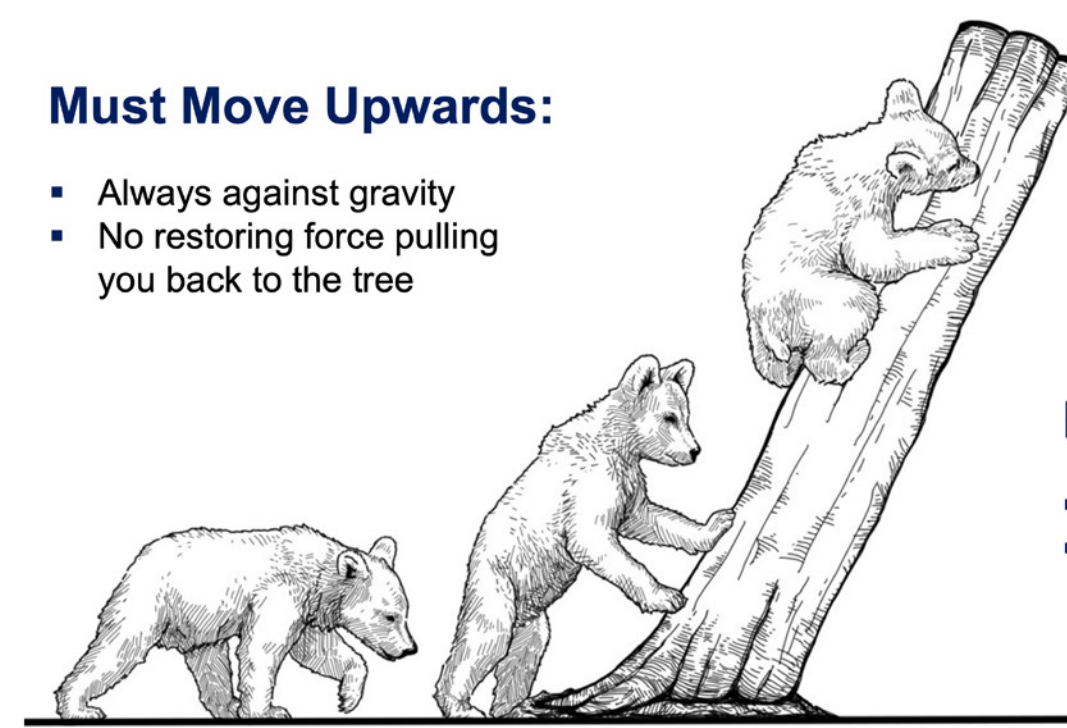
Gravity

Must Hang On:
- Grip or claws
- Contact Patterns

Illustration by Benjamin Seleb

Do mammals use pendular dynamics in climbing, too?

Hypothesis:

If mammalian climbers are subject to pendular dynamics, then we can predict time constraints for when limbs must recontact
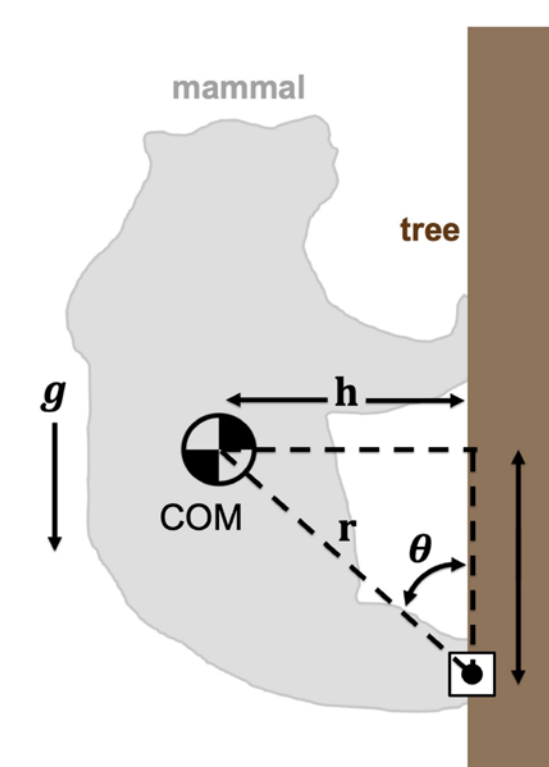
Start position   Pendulum fall   Pendulum catch   Reset

We can model the bounding gait as a pendulum

Theoretical time scale for allowable time to fall
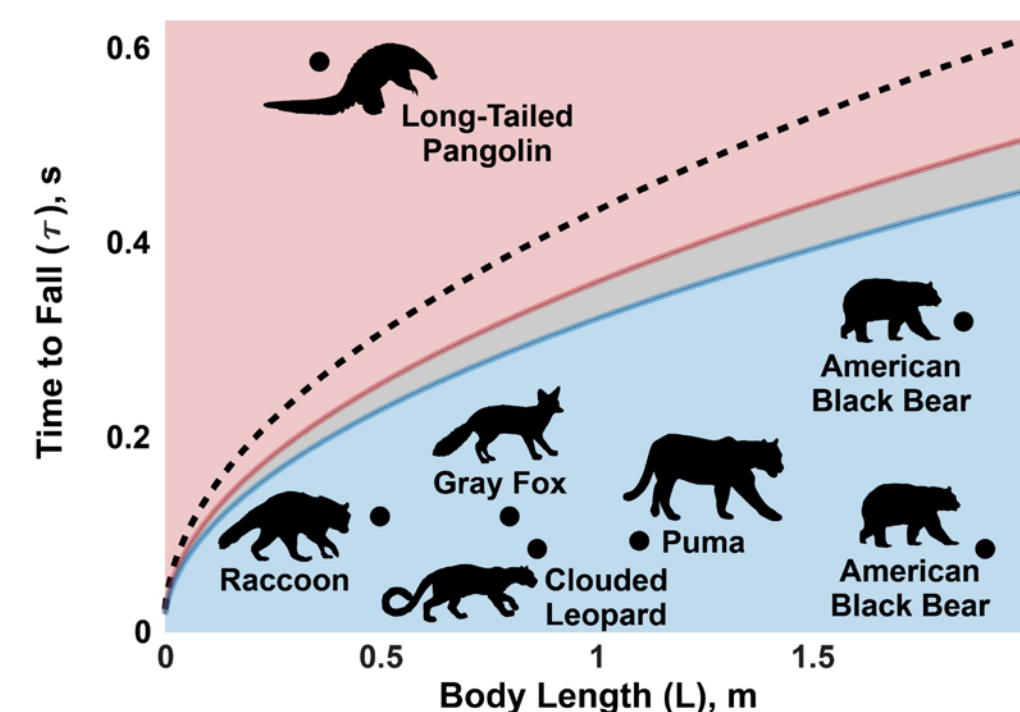
$$T = \sqrt{\frac{h^2 + \frac{L^2}{4}}{gh}}$$

mammal   tree

g COM h r θ $\frac{L}{2}$

Experimental data acquired via animals at Zoo Atlanta and from online videos

ZOO ATLANTA   YouTube

Most climbing mammals using the bounding gait seem to exhibit pendular dynamics...

- Time to fall is too long
- Theoretical time to fall cutoff range
- Time to fall is short enough

- - - $h = 0.15 * L$
— $h = 0.25 * L$
— $h = 0.5 * L$

Long-Tailed Pangolin

Gray Fox

Puma

Raccoon   Clouded Leopard

American Black Bear

American Black Bear

Time to Fall (τ), s

Body Length (L), m

... but the long-tailed pangolin relies on muscular action!

The time delay between forelimb release and recontact is too long for pendular dynamics

Instead, the pangolin uses muscular actions for *slow* extension upwards

Scholar Awards Celebration
November 13, 2024

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