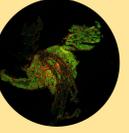


# Investigating the Effectiveness and Benefits of a 3D Printed Ladder for Rat Resistance Training Compared to Previously Published Models

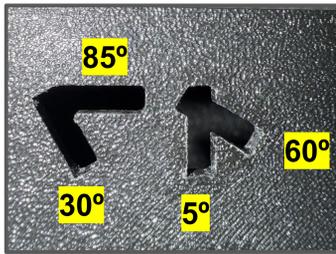
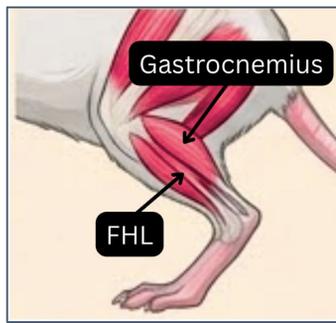


Raghav Sharma, Jennifer A. Stokes, PhD

Department of Kinesiology, Southwestern University; 1001 E University Ave; Georgetown, Texas; 78626

## Background

- Ladder climbing was selected because it is less stress inducing than the squat or water jumping test<sup>4</sup>
- Several limitations were observed in the previous ladder model such as:
  - Step shape (cylindrical vs. round) promoted flexor hallucis longus (FHL) hypertrophy over more superficial muscles such as the gastrocnemius<sup>3</sup>
    - rats exhibited grip and push climbing (GPC) which facilitated FHL hypertrophy
  - rigid incline led to quicker adaptation protocols<sup>1</sup>



## Purpose/Hypothesis

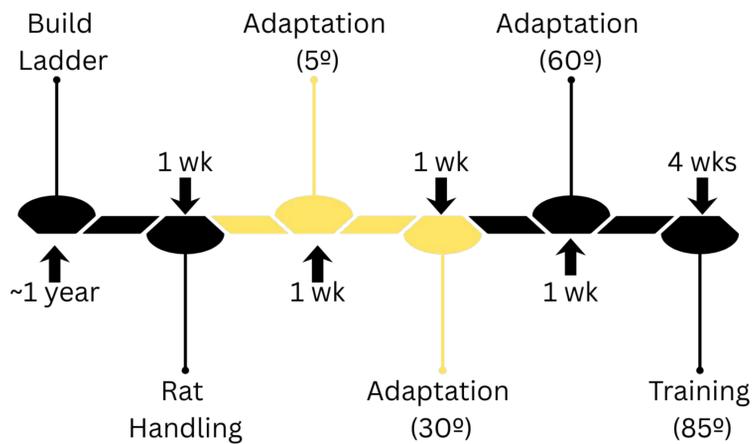
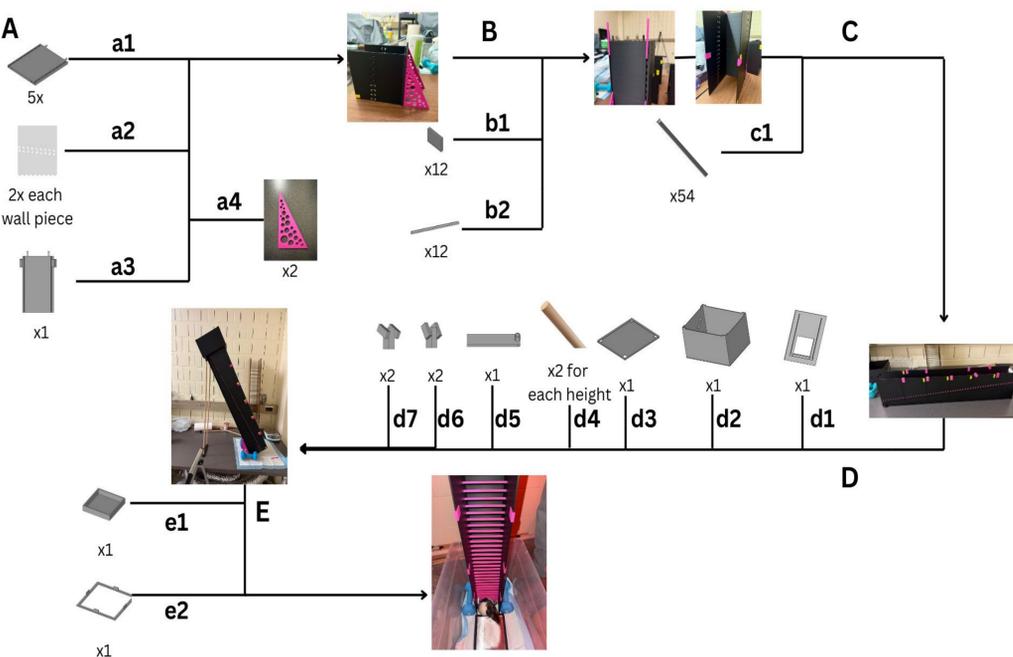
- The purpose of this study is to determine if rats will complete an exercise protocol with a 3D designed and printed ladder
- This ladder will address the limitations observed in previous models
  - Rigidity:** Previous models are immobile, the new ladder will have 4 angle settings (5°, 30°, 60°, 85°)
  - Stair shape:** the new ladder will use rectangular flat steps instead of cylindrical rungs
- I predict that the new ladder will make acclimation easier by allowing rats to climb at lower angles first before progressing up, and rats will exhibit plant and push climbing (PPC) intended to activate larger more superficial muscles such as the gastrocnemius

## Methods

### 3D printed ladder:

- Used a Bambu Lab X1 Carbon printer (0.20mm strength, 15% rectilinear infill)
- PLA plastic
  - Total filament cost: ~2,939.1 g (~\$50)

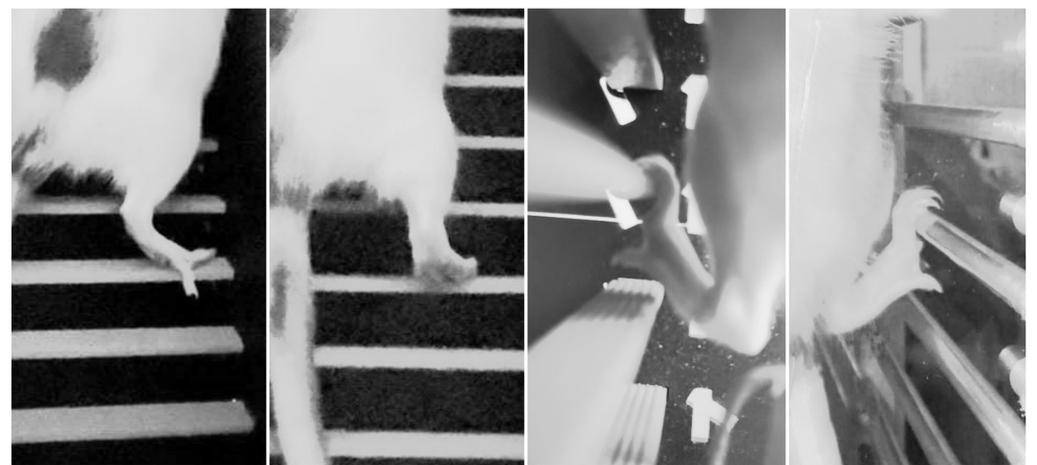
All animal protocols were approved by the Southwestern University Institutional Animal Care and Use Committee (IACUC Stokes\_1025)



←Schematic of the exercise protocol that was completed. At least 1 day of rest was given after each training day.

## Results

- All rats completed the acclimation stage with no problems
- Rats were able to climb up to 90% of their body weight
- PPC was exhibited at the 60° incline on the new model
- GPC was exhibited at higher inclines on the new model and old model



60° Incline

85° Incline

Old Model



3D Print Video



Video of rats climbing at all inclines

### Subjects

- n = 6; Male Long Evans rats
- about 8 weeks old at start
- 2 rats were excluded

### Data Collected

Reps completed, body weight, climbing biomechanics, apparent stress, images, and videos

## Conclusions and Future Plans

- New ladder showed the possibility of better climbing 60° vs 85° incline protocols
  - Lower incline potentially better for human modeling
  - Modeling geriatric humans<sup>2</sup>
- New vs. Old ladder model (85°)
  - Is there a significant difference in muscle growth between ladder models?

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