

MOTIVATION

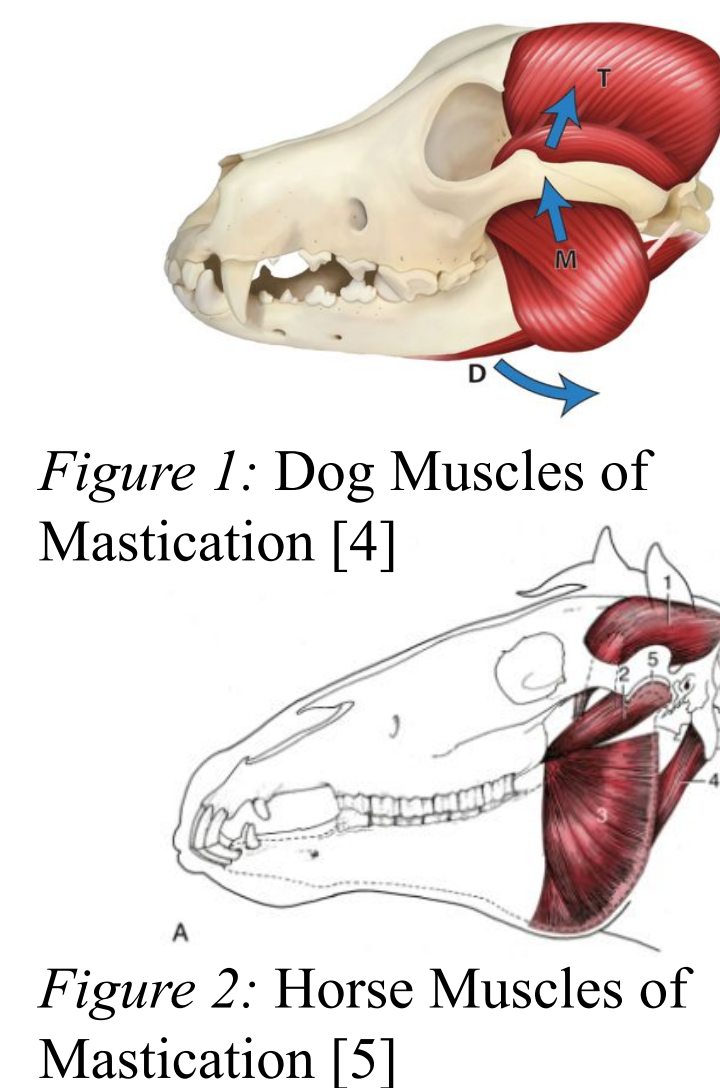
- Mastication muscles are attached to osseous structures of the skull
- They are involved in opening and closing the jaw for chewing
- Mastication varies widely across species due to differing diets and anatomy
 - Carnivores have a larger bite force for predation [1]
 - Herbivores have a circular bite to grind grass [1]
- Traditional education relied on cadaveric dissection, which comes with ethical and accessibility concerns [2]
- Understanding of mastication muscles is essential for veterinarians to maintain dental health and treat gastrointestinal issues in various species

PROBLEM STATEMENT

- No existing models demonstrate movement, function, and location for non-human animals [3]
- Dr. Gunderson has asked for two models that can be physically manipulated to show function and location of mastication muscles
- Will help train veterinary students on understanding anatomy and function

DESIGN CRITERIA

- Maintain integrity despite repeated elongation
- Under 10 lbs and capable of articulation
- No sharp edges or toxic materials
- Herbivore model (horse) and carnivore model (dog) must exhibit digastricus, temporalis, and masseter
- Horse model must also have pterygoid
- Models must showcase chewing motion



BACKGROUND

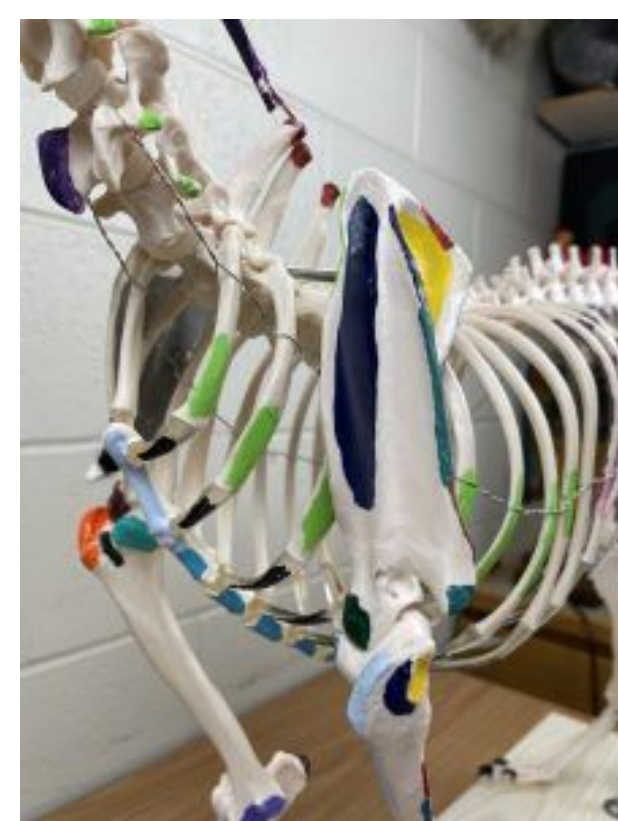


Figure 3: Dr. Gunderson's Painted Skeleton Model [6]



Figure 4: Axis Scientific's Life-Size Masticatory Muscles Anatomy Model [7]

- ✓ Manipulatable model
- ✗ Full Body
- ✗ Elastic degrades

- ✓ Mastication muscles
- ✓ Muscles stretch
- ✗ Human model

FINAL DESIGN

Herbivore Model Final Prototype Specifications

- Length: 16.51cm
- Weight: 183g



Figure 5: Herbivore Model Final Design

Carnivore Model Final Prototype Specifications

- Length: 19.05cm
- Weight: 243g

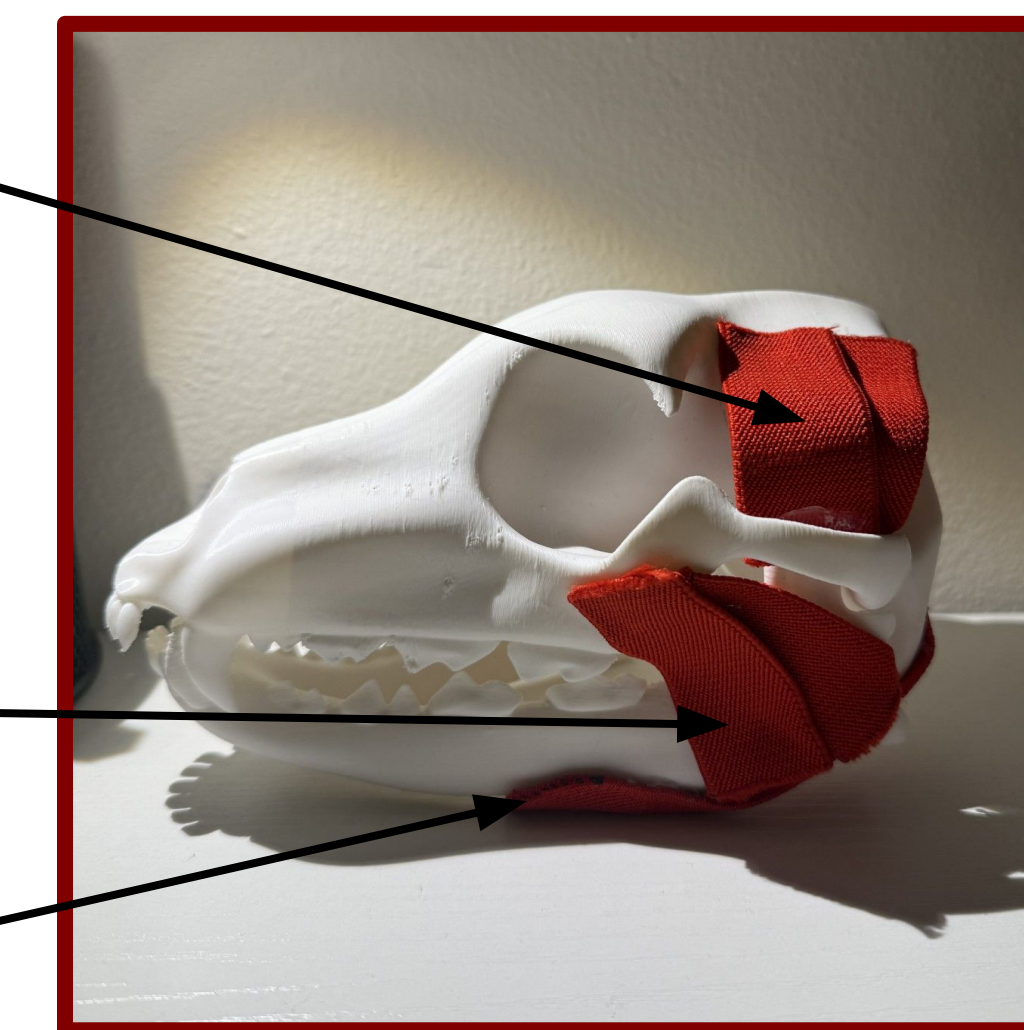


Figure 6: Carnivore Model Final Design

Fabrication

- Downloaded and prepared skull files in SolidWorks
- 3D printed skull with white polylactic acid (PLA)
- Located muscle insertions and origins
- Cut red elastic band and glue with hot glue gun

TESTING

Durability Testing

- Model was held by the top half, gravity being the only force acting upon it
- Distance was measured between the jaws using calipers
- Repeated 20 times



Figure 7: Canine Jaws Relaxed State

Usability Testing

- Each model's jaw was opened 20 times to the maximum angle
- Muscles were observed to move in anatomical directions [8]
- Slippage of elastic attachment was recorded

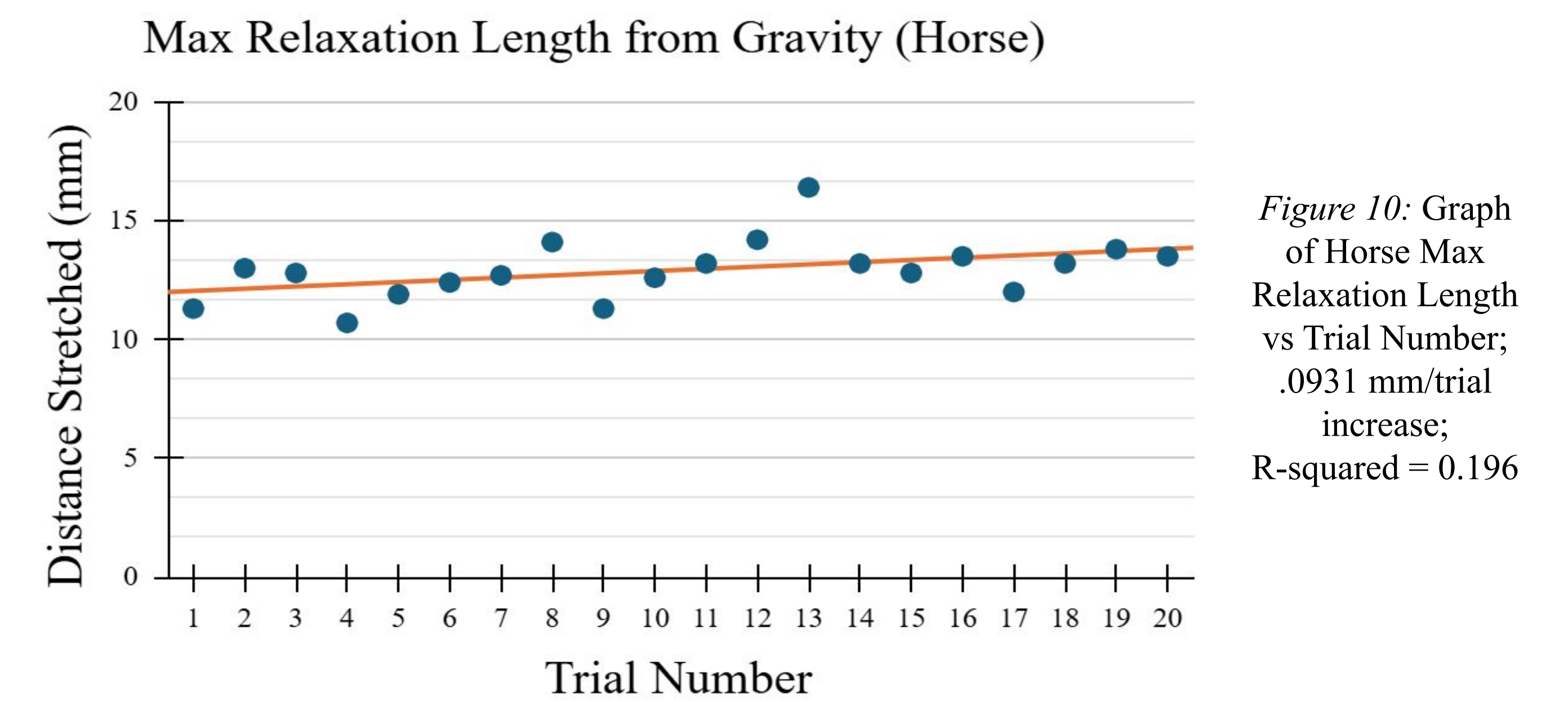
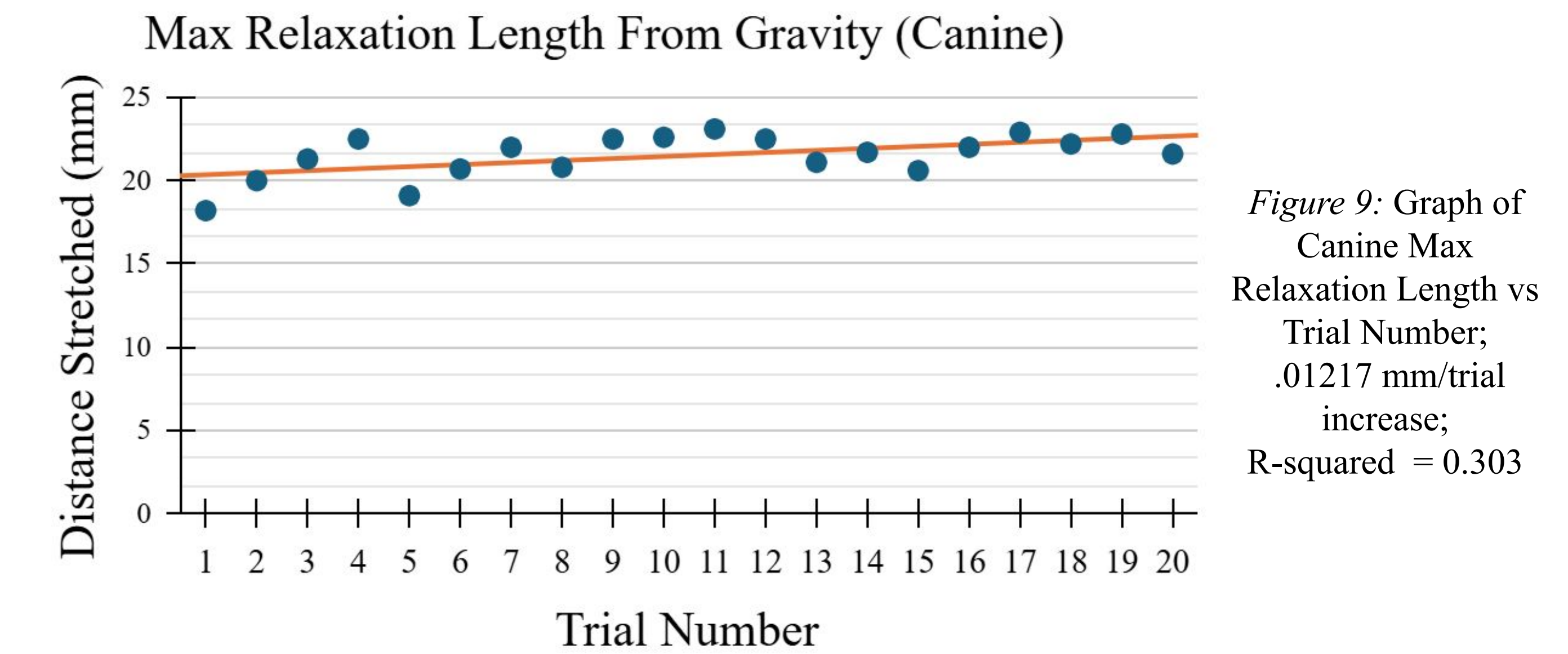


Figure 8: Horse Jaws at Maximum Angle

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RESULTS



DISCUSSION

- Little variation of relaxation length can be explained by trial number in relaxation test
- Usability test demonstrated movement within the range of anatomically correct jaw motions without detachment.
 - Research of mastication muscles often involves cadaveric samples
- Limited accuracy due to species-specific variability
- The muscle material was selected due to Thermal Polyurethane (TPU) lacking durability and elasticity required
- PLA skulls made it difficult to attach the muscles

FUTURE WORK

- Improving realism of muscles
- Adding additional muscles within the skull
- Gain feedback from students to improve educational usage
- Solid skull instead of hollow to refine attachment

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