Language Science Undergraduate Research Conference 2025:

Exploring Human Tongue Mobility Without Surrounding Bone Structure

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Question

- Does human **tongue mobility** differ when surrounding **bone** structure is **removed**?

Background

- The human tongue is classified as a **muscular hydrostat (MH)**
- **MHs** function **independently** of a solid **skeletal** system with hydrostatic pressure as mechanical support
  - E.g., trunks, tentacles, and tongues

- Prior studies also established the **tongue's** function to be **dependent** on interaction with **surrounding skeletal structures**.
- **Research gap**
  - Tongue mobility with and without surrounding bone
- **Why is this interesting?**
  - Investigation on mechanical support will enable comparisons between human MHs and non-human MHs.

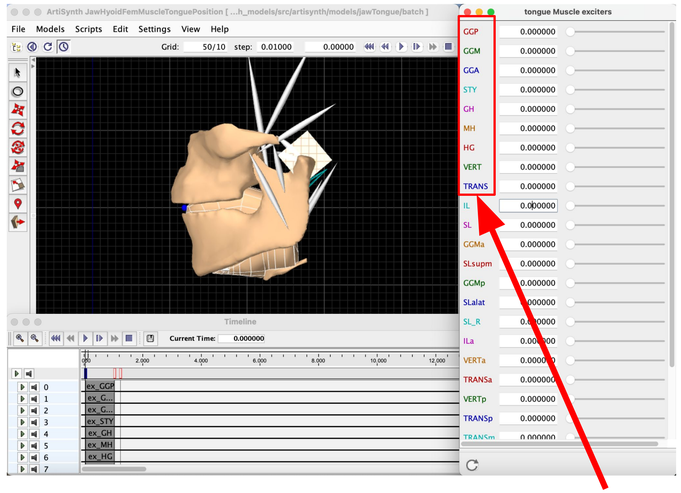
	Human Tongue + Lips	**Other Hydrostatic Muscles: tentacles, trunks**
Muscle Fiber Orientation	**Vertical/Transverse** orientation of muscle fibers	**Radial/Circular** orientation of muscle fibers
Mechanical Support	**(1) Hydrostatic pressure** **(2)** contact with **surrounding bone**	**Hydrostatic Pressure**

Hypothesis

- There will be **differences** in **tongue mobility** in the **absence** of supporting **bone** structure.

Methods

- 3D Interactive biomechanical simulation platform: **Artisynth**
  - Java-based API for model creation
- Using the **Jaw-Hyoid-Tongue complex model** to run the simulations



Tongue Muscle Exciters

Experimental Variables:

- **Input to simulations:** Combinations of muscle excitations of the tongue muscles + activation of bones—mandible and maxilla.
- **Output of simulations:** Coordinates of various points on tongue

Experimental Trials

- Employing an **automatic simulation** program to run all possible combinations of muscle pairings and excitations at level 0%, 10% and 25%
  - 9 **Excitor Muscles**
- Position of tongue points tracked through probe attachments with a sampling rate of 0.01 seconds

Methods cont.

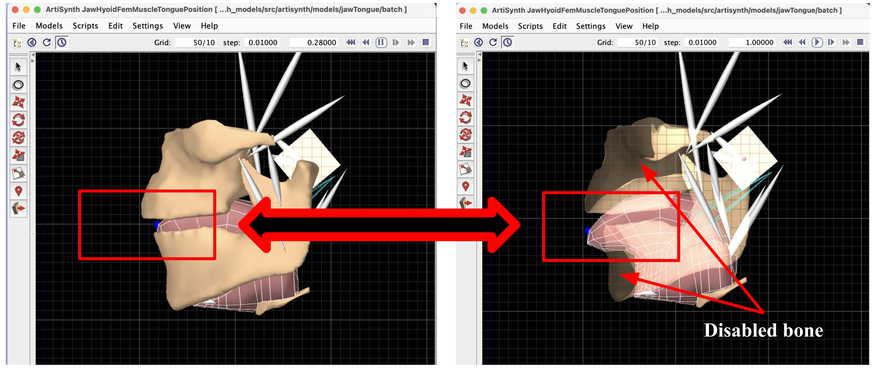
Experimental Conditions

1. Control **2. Experimental Condition**

Example: Transversus Muscle Excitation at level 25%

With surrounding **bone** structure → maxilla and mandible

Without surrounding **bone** structure → maxilla and mandible



Preliminary Results:

- Activation of Transversus Muscle:
  - **Increase** in tongue tip distance travelled with **deactivated skeletal structures** in comparison to activated bone structures.

Next Steps

- Finish running all simulations through Artisynth and data analysis
- Interested in how muscle fiber orientation influences tongue movement
  - Further research will investigate the mobility of a human tongue compared to radially organized muscular hydrostats—tentacles.

References

1. Hiiemae K.M. & Palmer J.B. (2003). Tongue Movements in Feeding and Speech. Critical Reviews in Oral Biology & Medicine,14(6):413-429. doi:10.1177/154411130301400604
2. Kier, W. M., & Smith, K. K. (1985). Tongues, Tentacles and Trunks: The Biomechanics of Movement in Muscular-Hydrostats. Zoological Journal of the Linnean Society, 83(4), 307-324. http://dx.doi.org/10.1111/j.1096-3642.1985.tb01178.x
3. Lloyd, J. E., Stavness, I., & Fels, S. (2012). ArtiSynth: A fast interactive biomechanical modeling toolkit combining Multibody and finite element simulation. Studies in Mechanobiology, Tissue Engineering and Biomaterials, 355-394. https://doi.org/10.1007/8415_2012_126
4. Roewer-Despres, F. (2018, June 29). The Batch Simulation Framework. https://file:///Users/mashachernets/Downloads/batchsim%20(3).pdf
5. Sanders, I., Mu, L., Amirali, A., Su, H., & Sobotka, S. (2013). The human tongue slows down to speak: Muscle fibers of the human tongue. The Anatomical Record, 296(10), 1615-1627. https://doi.org/10.1002/ar.22755
6. Sanders, I., & Mu, L. (2013). A three‐dimensional atlas of human tongue muscles. The Anatomical Record, 296(7), 1102-1114. https://doi.org/10.1002/ar.22711