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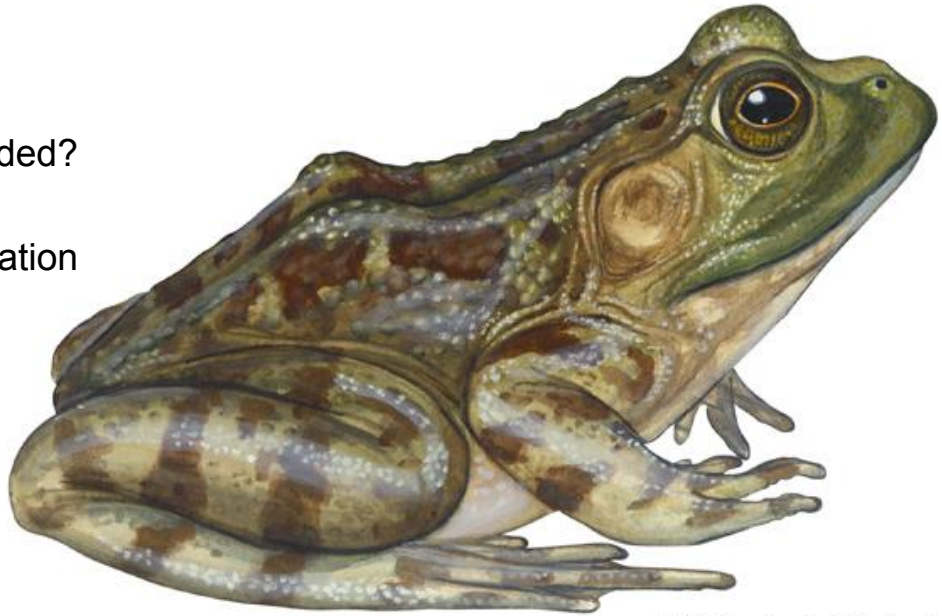
2016

Properties of *Rana caeli* Nerve Fibers

receptive fields, conduction velocity, and thermoreception

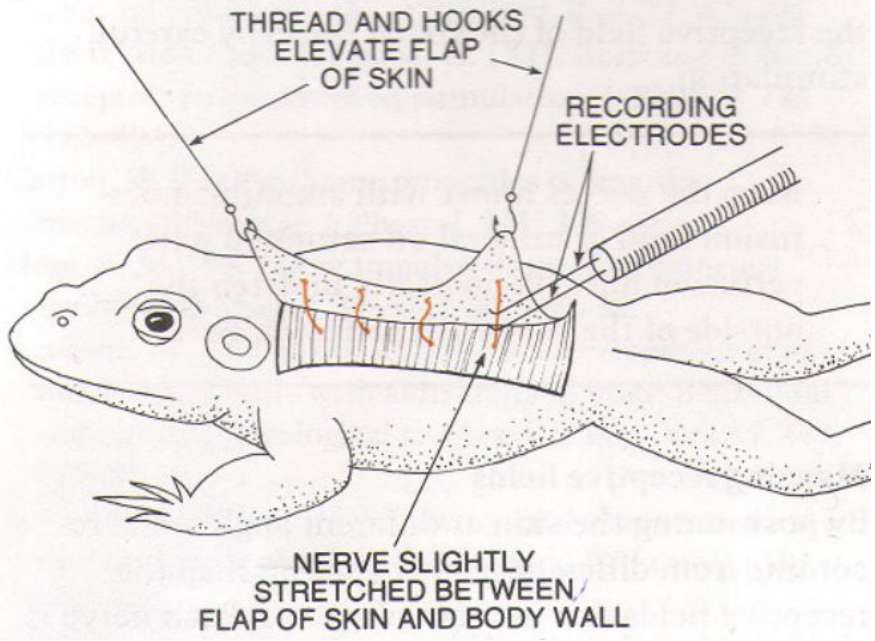
Introduction

- The organism: *Rana caeli* (space frog)
  (Discovered by NASA)
- Objectives
  - How is tactile information from skin encoded?
  - Examine response properties and innervation patterns for tactile and heat stimuli

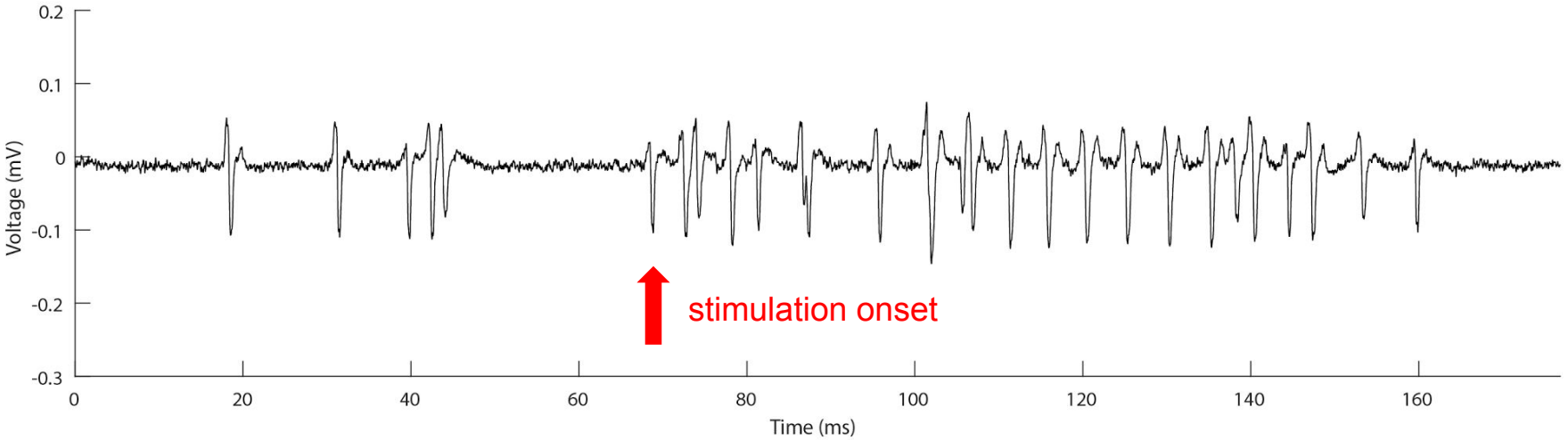


Methods (part 1)

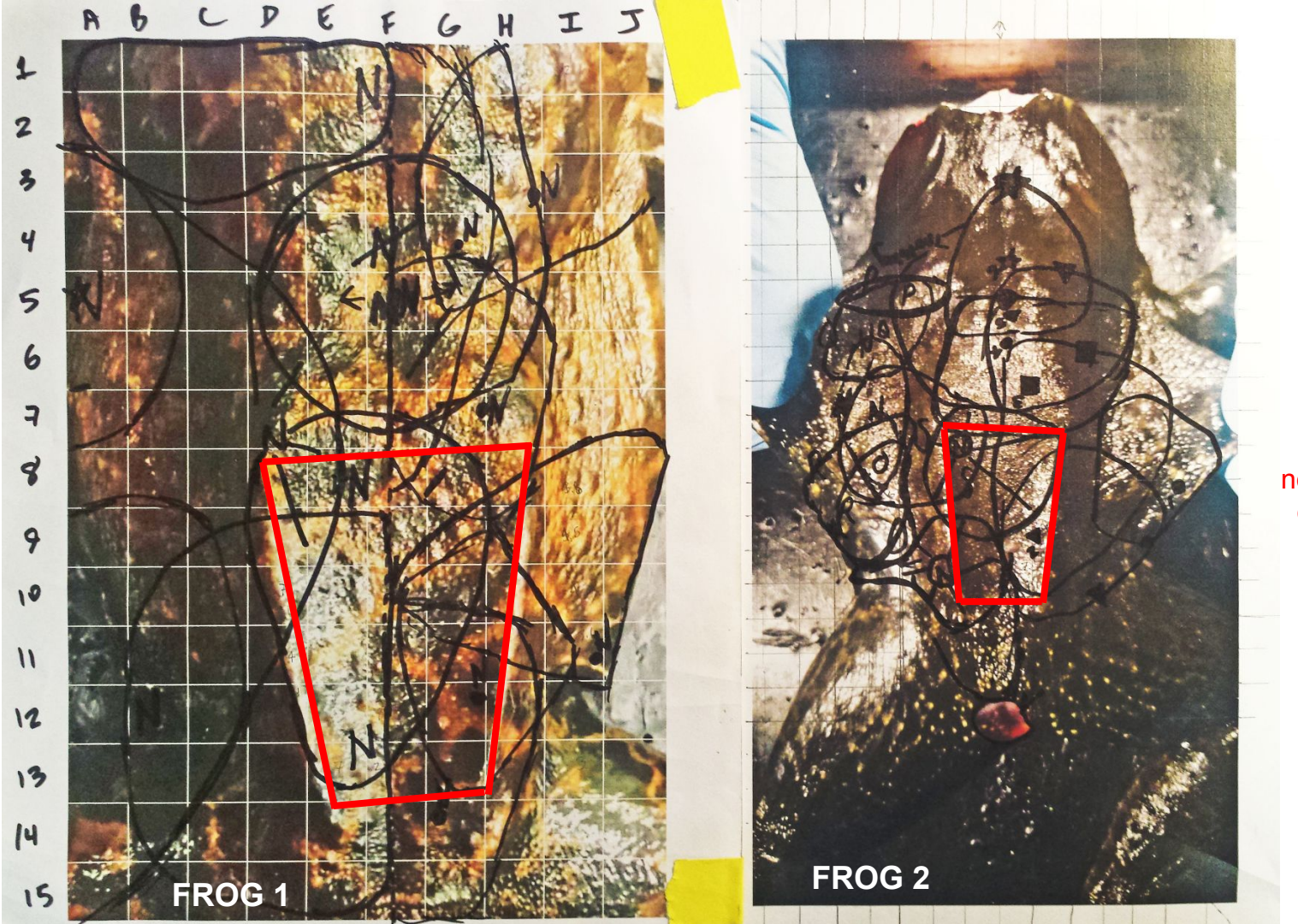
- Cut square section of skin from dorsal side and lift flap
- Recorded from nerve fibers that innervate the skin
- Standard procedure
    - Stroked the skin of the frog and noted spiking, recorded positions where spiking occurred as “receptive fields”
    - Receptive fields were determined using both visual and auditory feedback methods



Representative Trace of Mechanoreceptor Stimulation



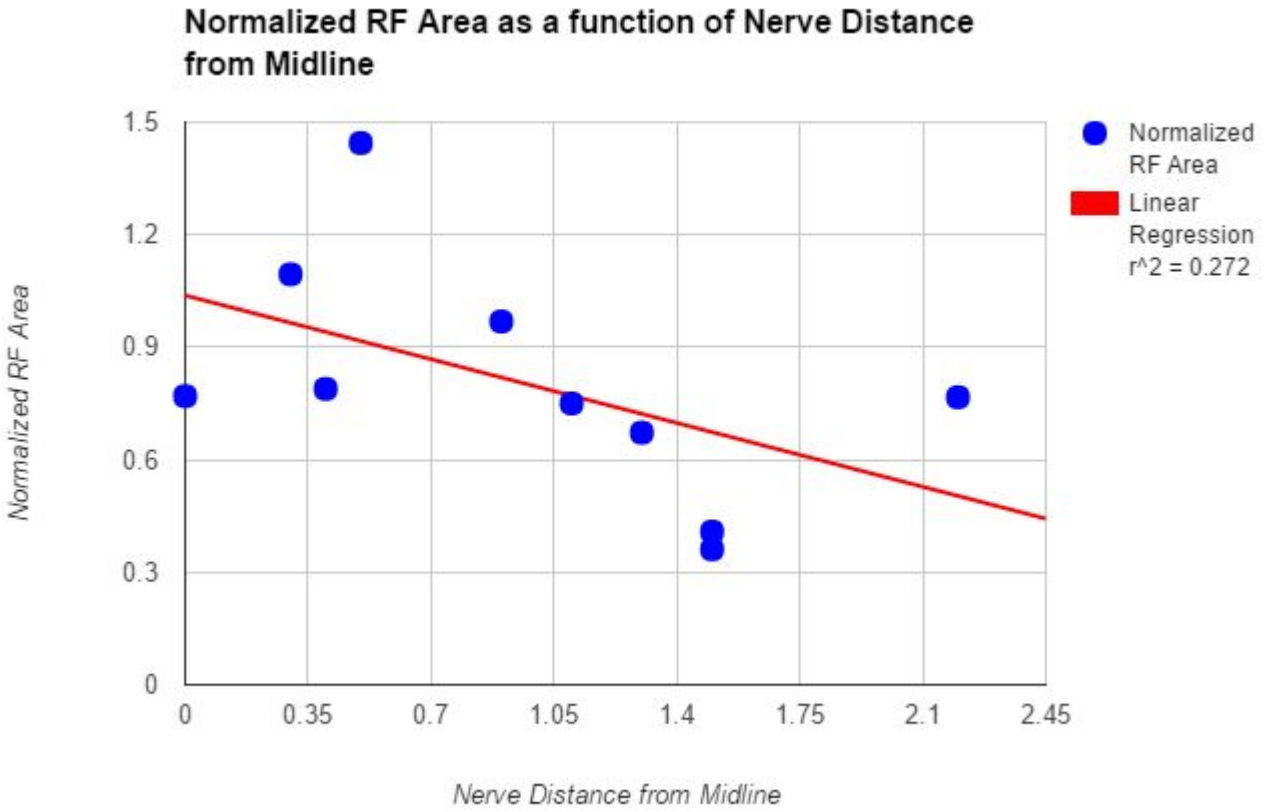
- Multiunit recording from nerve fiber, not spike-sorted
- Increase in firing rate due to tactile stimulation



Hip area used for normalization of RF size.

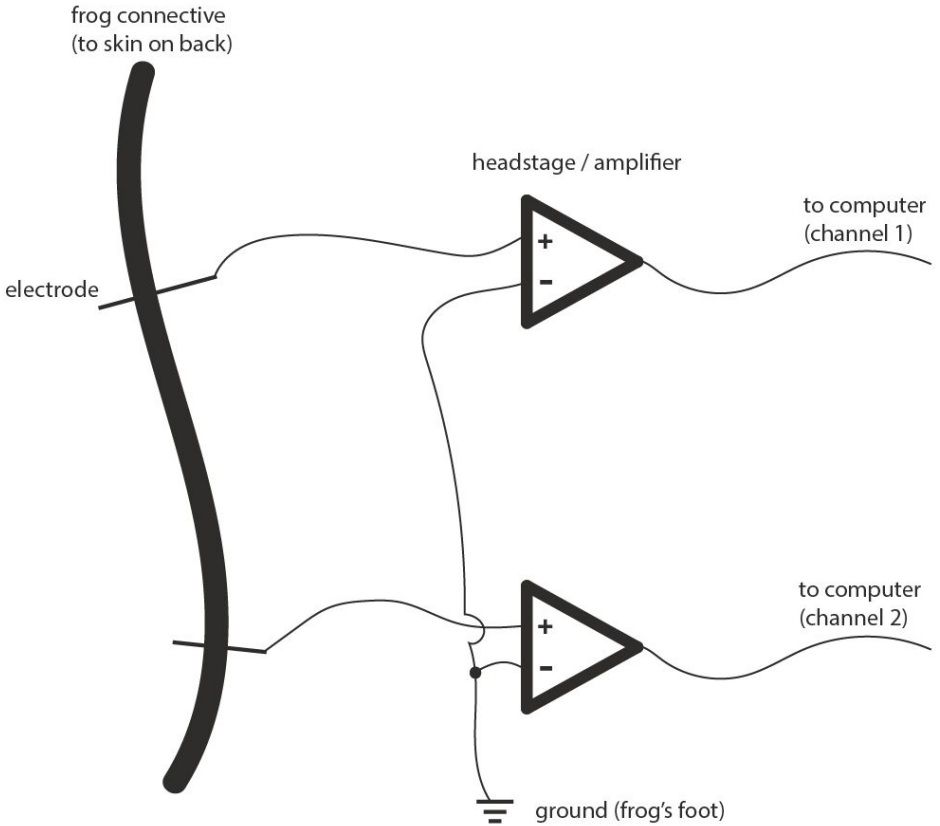
Receptive Fields (RFs)

- Smaller RFs were found laterally
    - Some proximal receptive fields were cut off
- Larger RFs were found medially

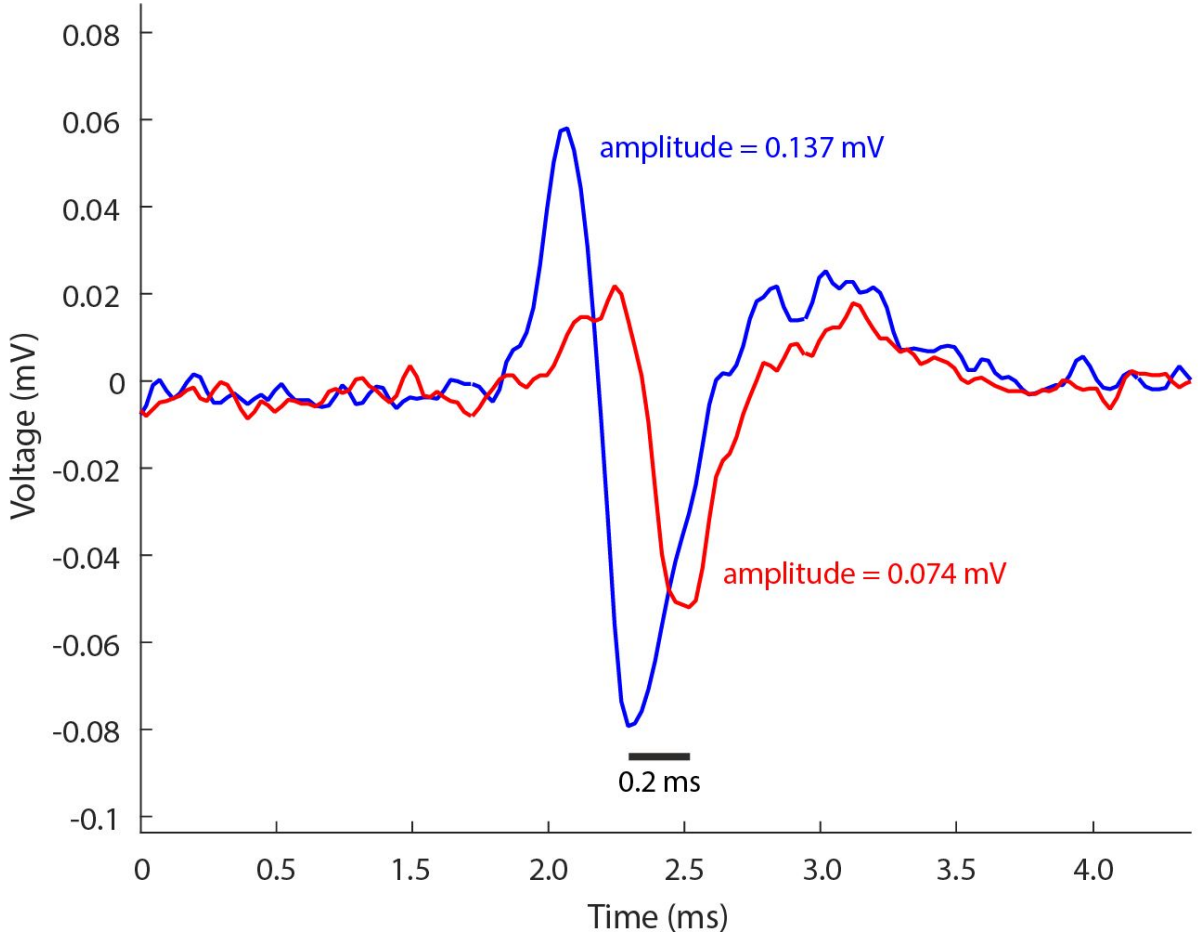


Methods (part 2)

- Conduction velocity
  - Placed two electrodes on nerve fiber
- Heat procedure
  - Open heat source (flame) near frog skin; recorded change in elicited firing rate with heat
  - Temperature recorded with IR temperature gun
  - FR determined in post-processing

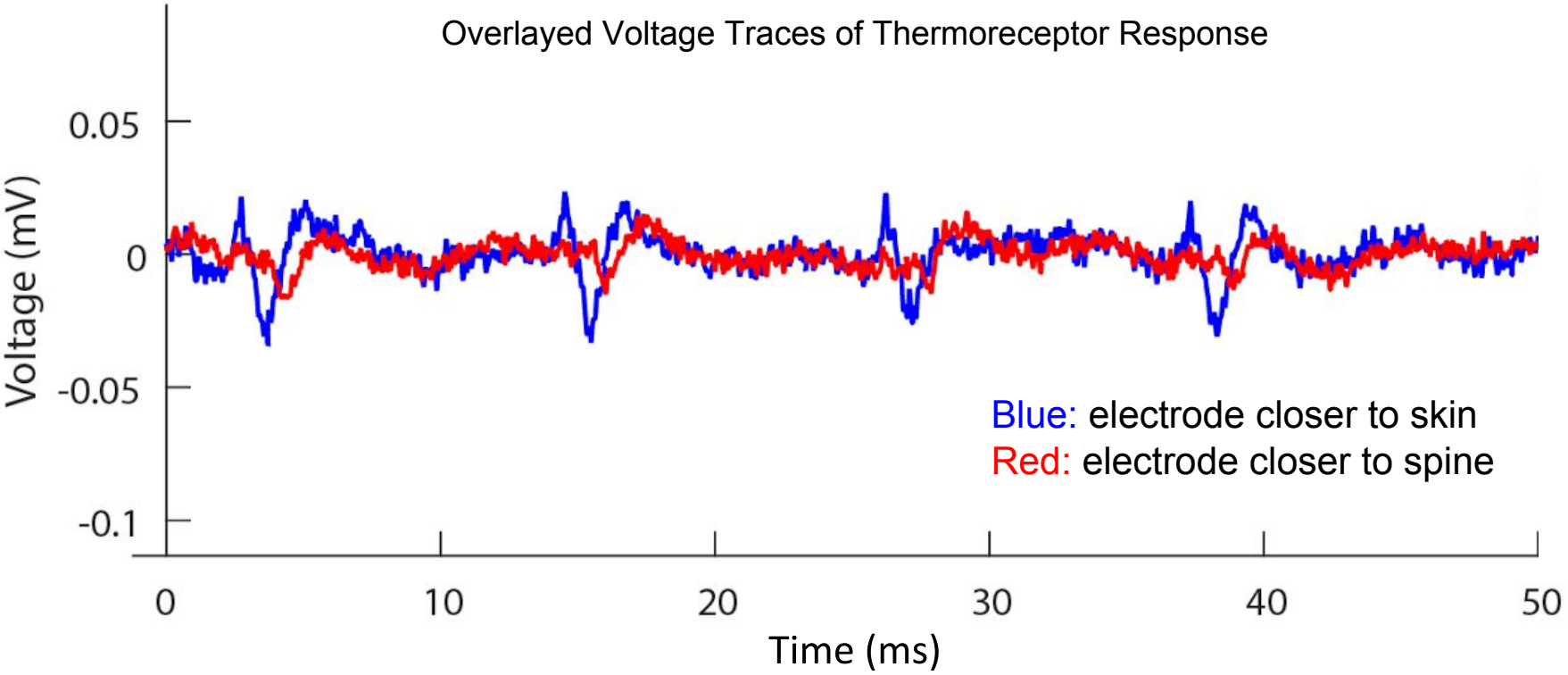


Conduction Velocity (mechanoreceptors)



Blue: electrode closer to skin
Red: electrode closer to spine

Conduction velocity:
23.81 m/s to 33.33 m/s

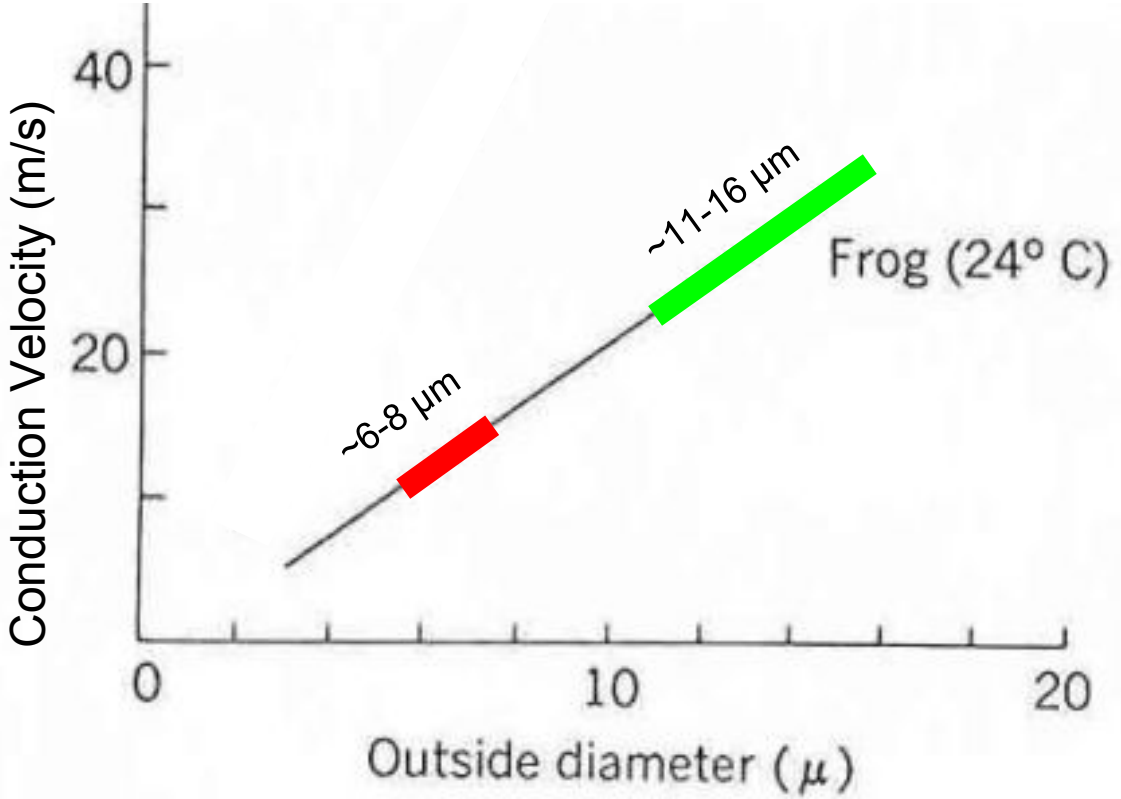


- Calculated Conduction Velocity Range
  - **11.43 m/s to 15.24 m/s**

Mechanoreceptor and Thermoreceptor Conduction Velocities

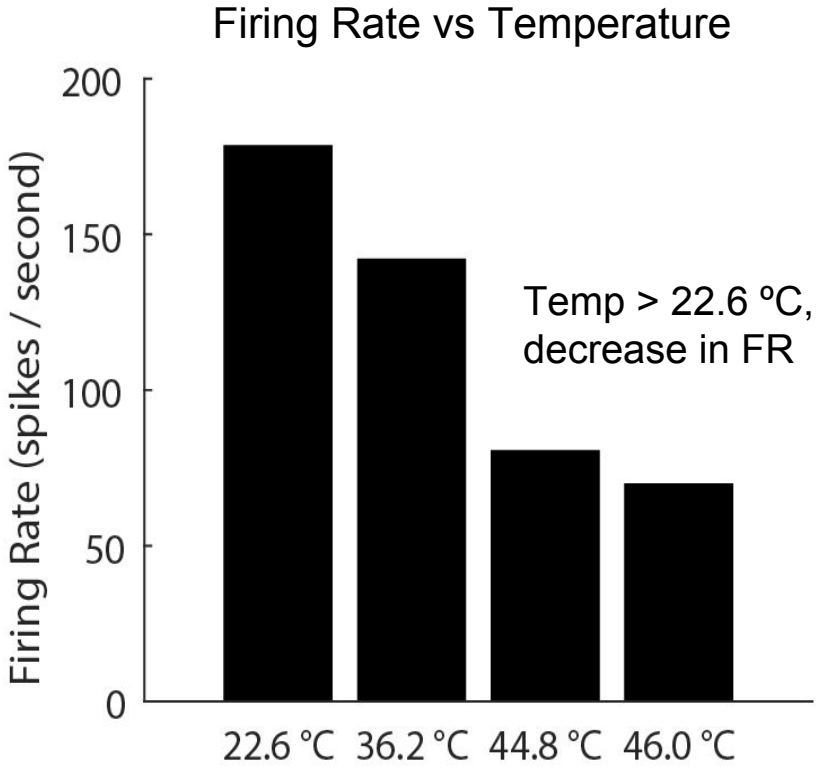
Mechanoreceptor Conduction Velocity: **23.81 m/s to 33.33 m/s** (**GREEN**)

Thermoreceptor Conduction Velocity: **11.43 m/s to 15.24 m/s** (**RED**)

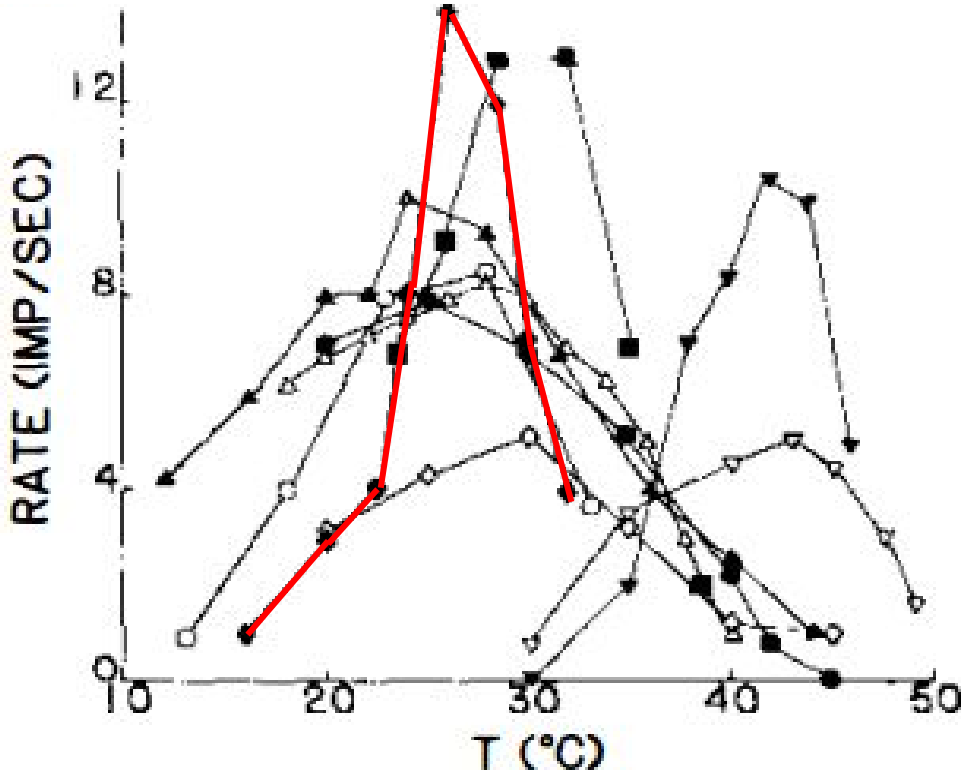


Adapted from Figure 2-29 in Lab Manual 2A.

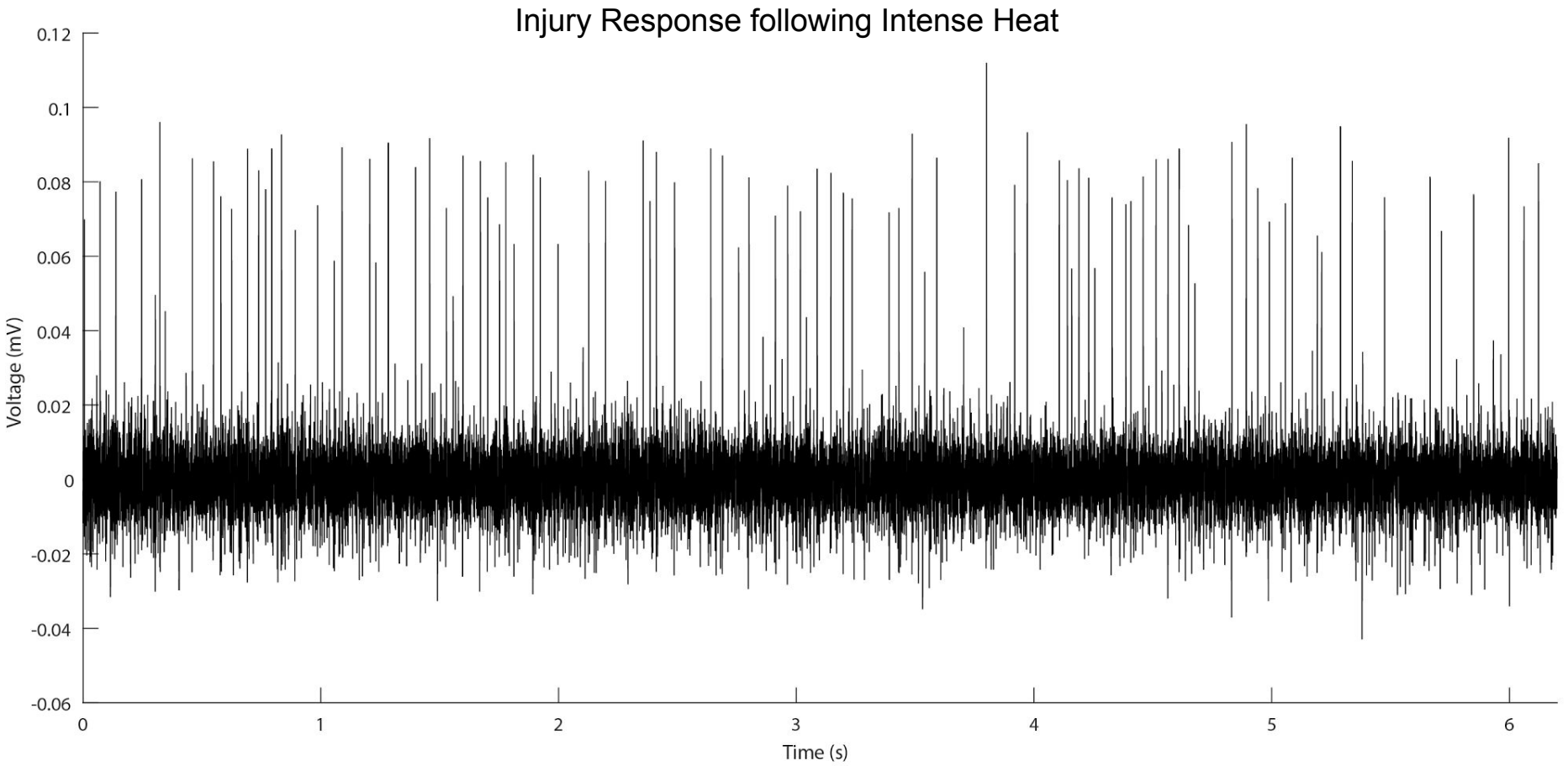
Red Line: FR of frog thermoreceptors in response to Temperature



Baseline Skin Temperature: 19.6 °C



Adapted from Figure 1A, Spray et al., 1986.



FR = 14.8 spikes/second

Conclusions

- RF size decreases with distance from midline
- Difference in response properties by tactile and heat stimuli suggests multiple nerve fibers present

	Mechanoreception	Thermoception
Conduction Velocity (m/s)	**23.81 to 33.33**	**11.43 to 15.24**
Estimated Diameter (μm)	**11 to 16**	**6 to 8**

Sources of Error

- Stretching skin distorts RF sizes
- **Difficult to pinpoint nerve on paper**
- Inability to record from single nerve fibers
- Accurately measuring and maintaining distance between electrodes when recording conduction velocity
- **Could not record temperature over time while applying heat**
- **Coarse method of applying heat**

Next Steps

- **Devise a procedure to more accurately map RFs**
- Test two-point discrimination for lateral versus medial nerve fibers
- **Build / use recording device with fixed distance between electrodes**
- **Develop method to increase and continuously record skin temperature over a larger temperature range**
- Experimentally determine mechanoreceptor and thermoreceptor fiber diameters

Sources

Govindarajulu, P., Price, W. S., & Anholt, B. R. 2006. Introduced Bullfrogs (Rana catesbeiana) in Western Canada: Has Their Ecology Diverged?. Journal of Herpetology 40:249-260.

Spray, D. C. (1986). Cutaneous temperature receptors. Annual Review of Physiology, 48(1), 625-638.

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Stein, J. (2016). Lab Manual 4: Skin Receptive Fields: Frog Cutaneous Receptors [Class Handout]. Department of Neuroscience, Brown University, Providence, RI.


FROG