Fall 2019

CS6501: Topics in Human-Computer Interaction

http://seongkookheo.com/cs6501_fall2019

Haptics

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Haptics

- Haptic: adj. relating to or based on the sense of touch
  - from the Greek *haptesthai* (to grasp, touch)

Cutaneous

Texture
Temperature
Slip
Vibration

Kinesthetic

Location
Motion
Force

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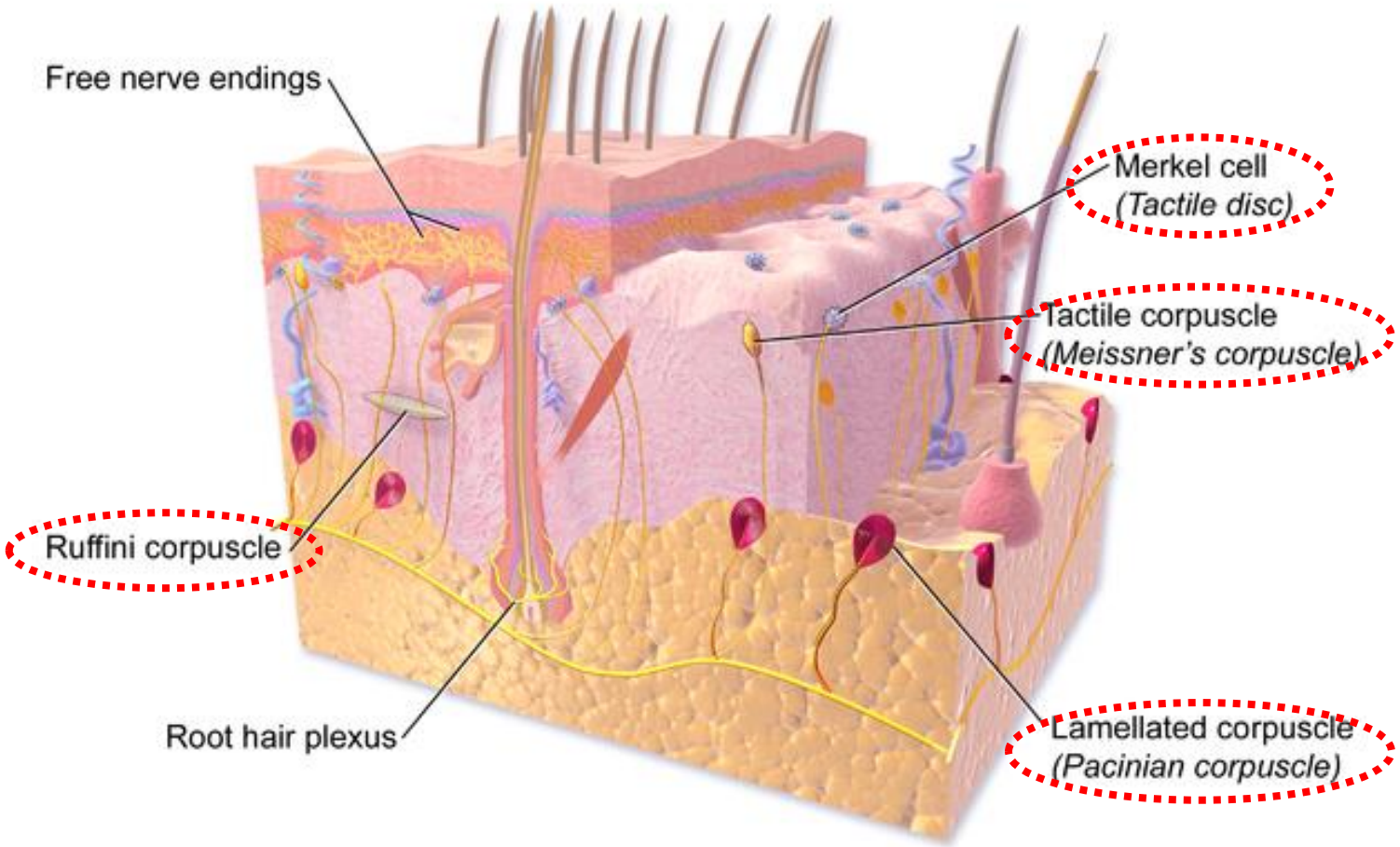
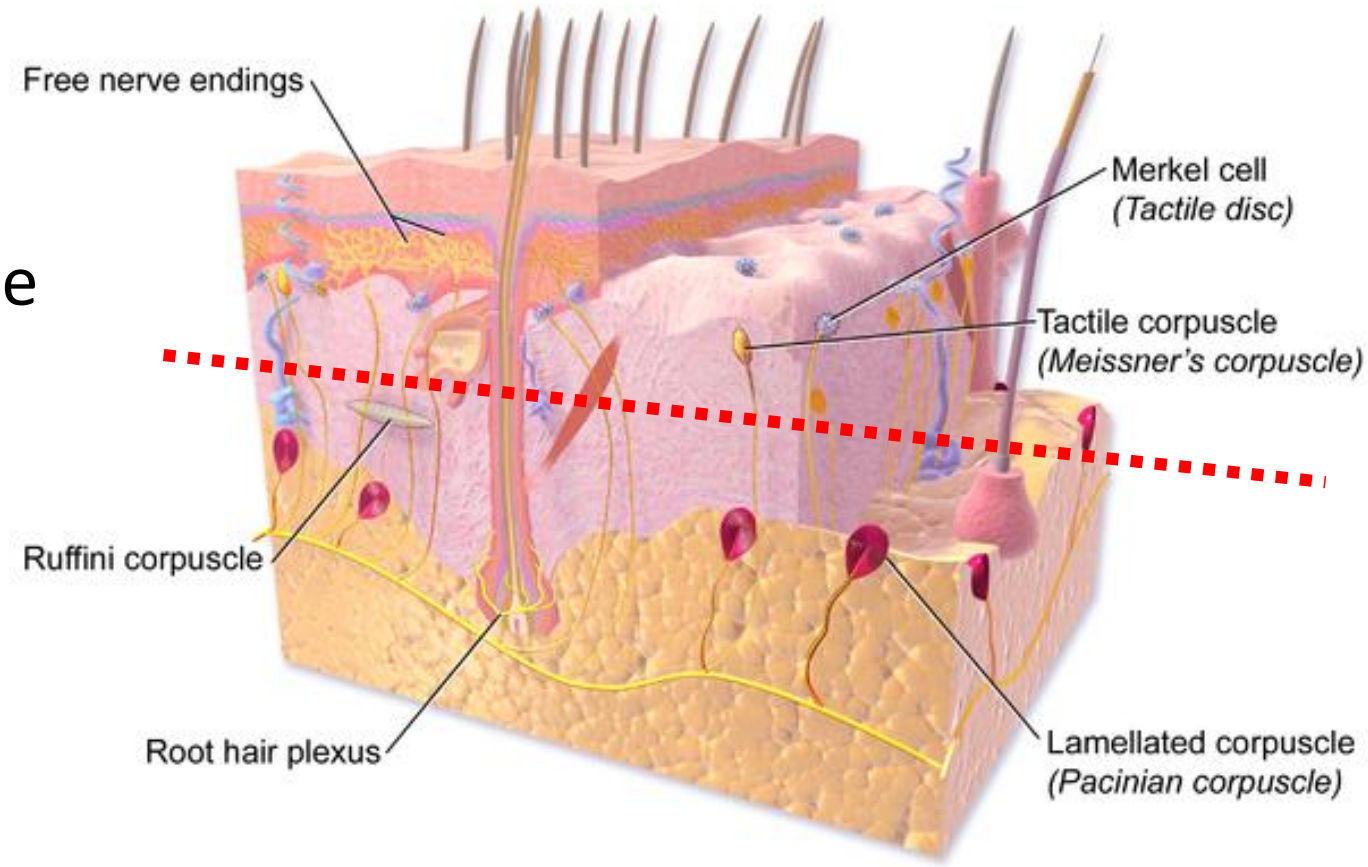
Mechanoreceptors



Mechanoreceptors

- By depth
  - I: Closer to skin surface
  - II: Deeper beneath surface



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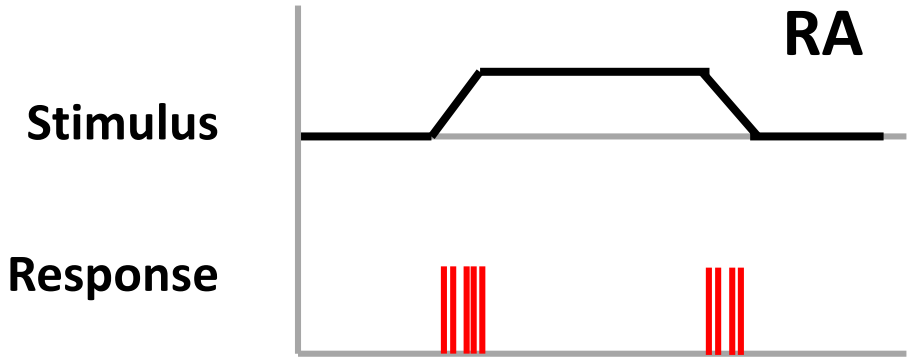
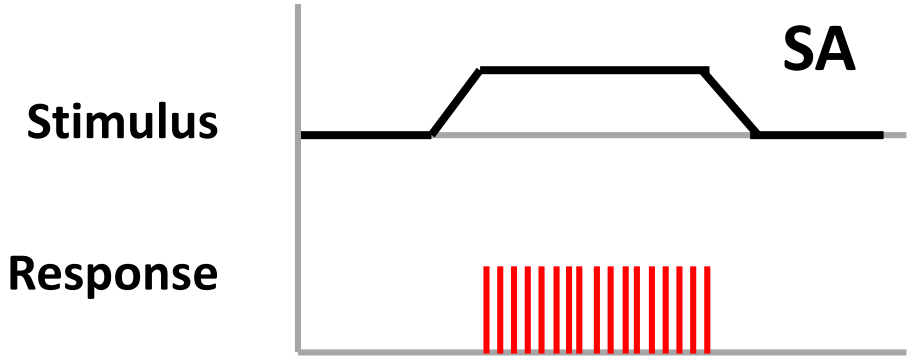


- By adaptation rate
  - Rapidly Adapting
  - Slowly Adapting



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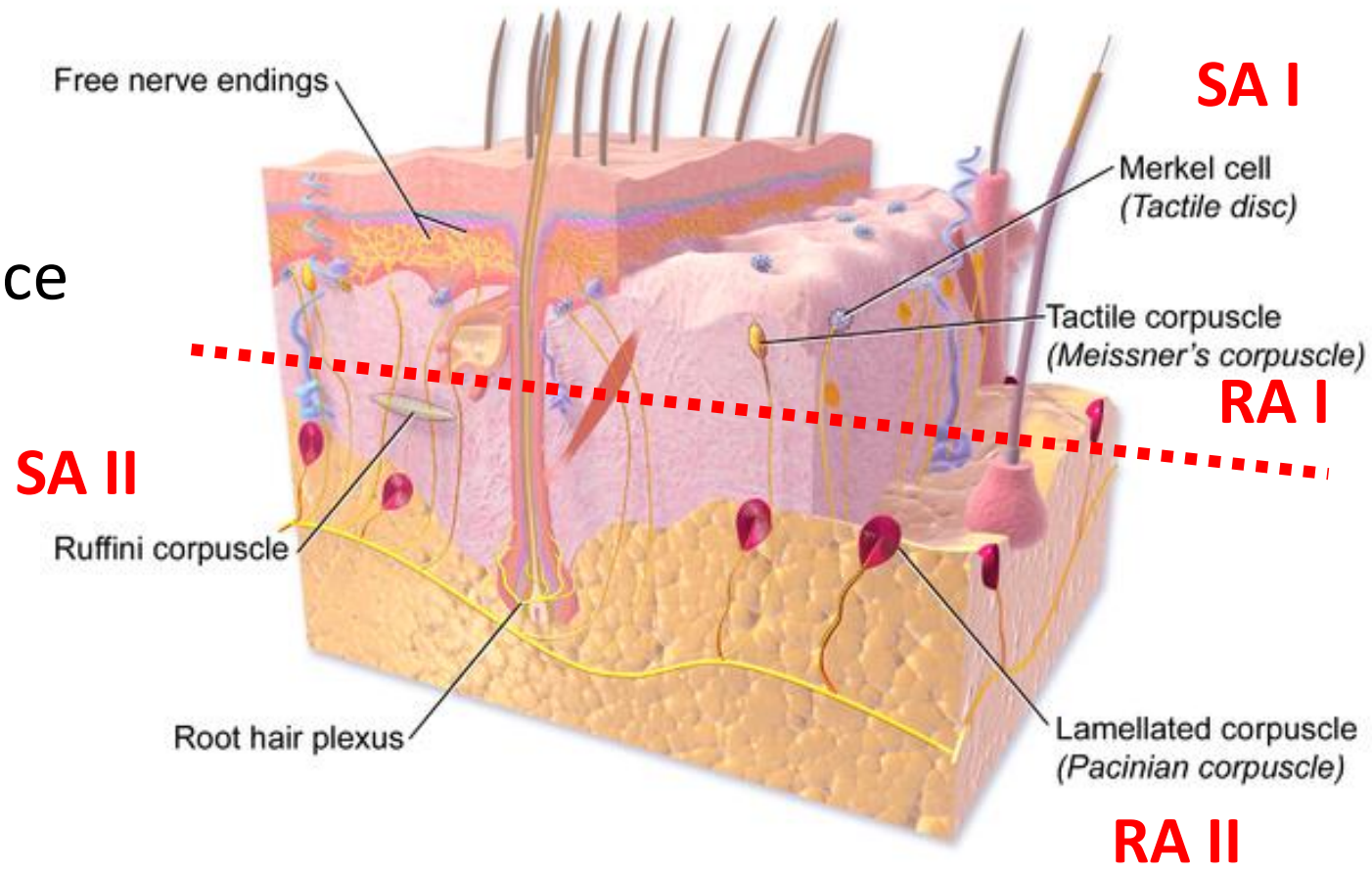
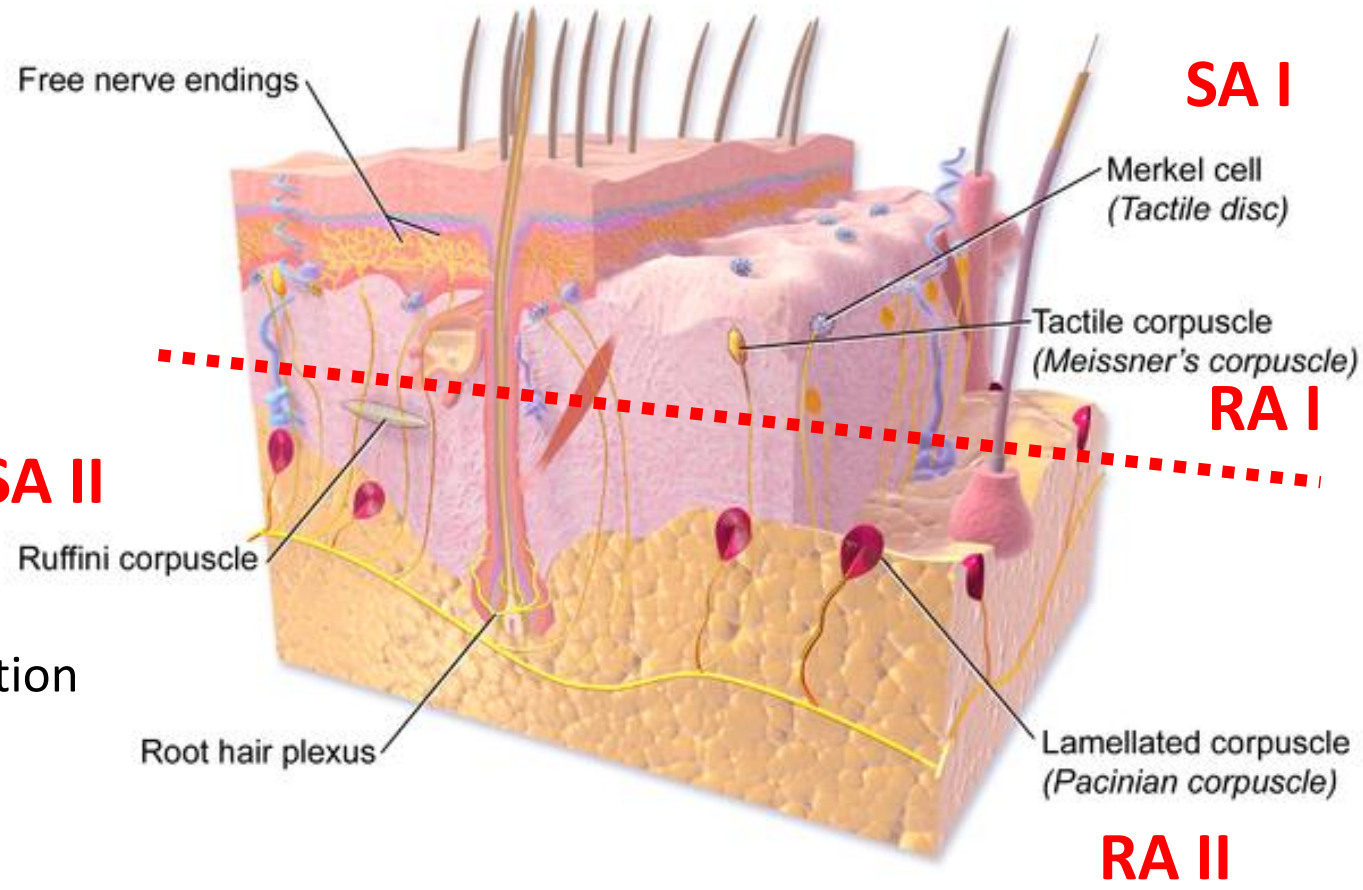
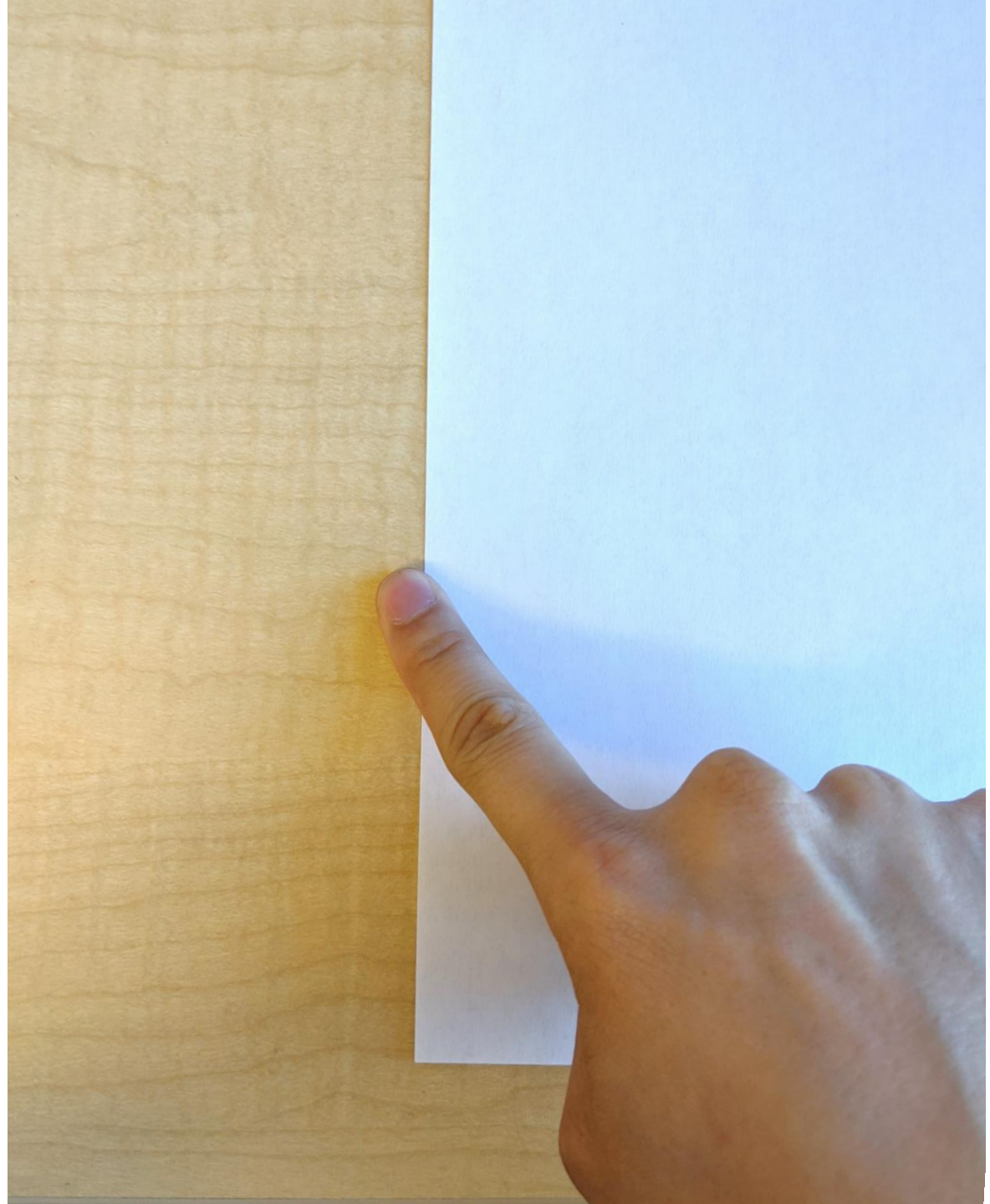


Mechanoreceptors

- Merkel (SA I)
  - Perceiving form and texture
  - Low frequency vibrations
- Ruffini (SA II)
  - Skin deformation and stretch
- Meissner (RA I)
  - Motion, slip, dynamic skin deformation
- Pacinian (RA II)
  - High frequency vibration





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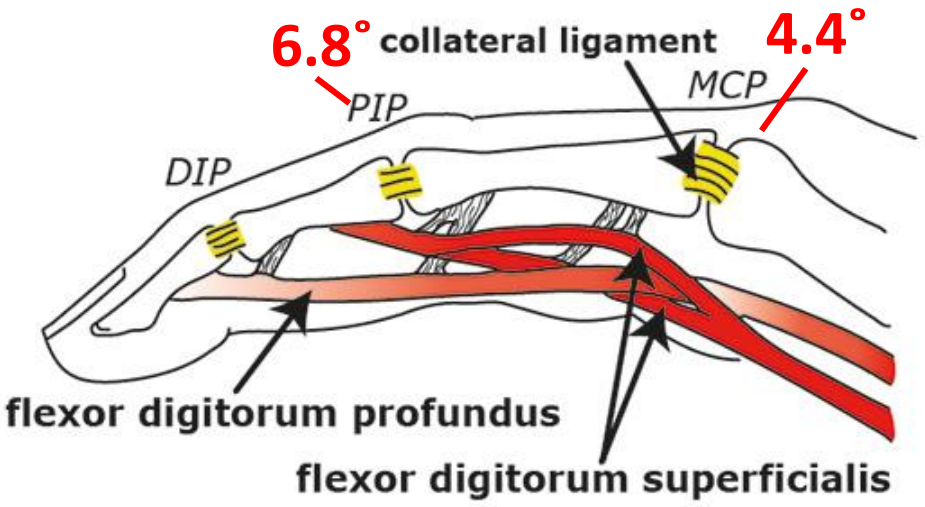
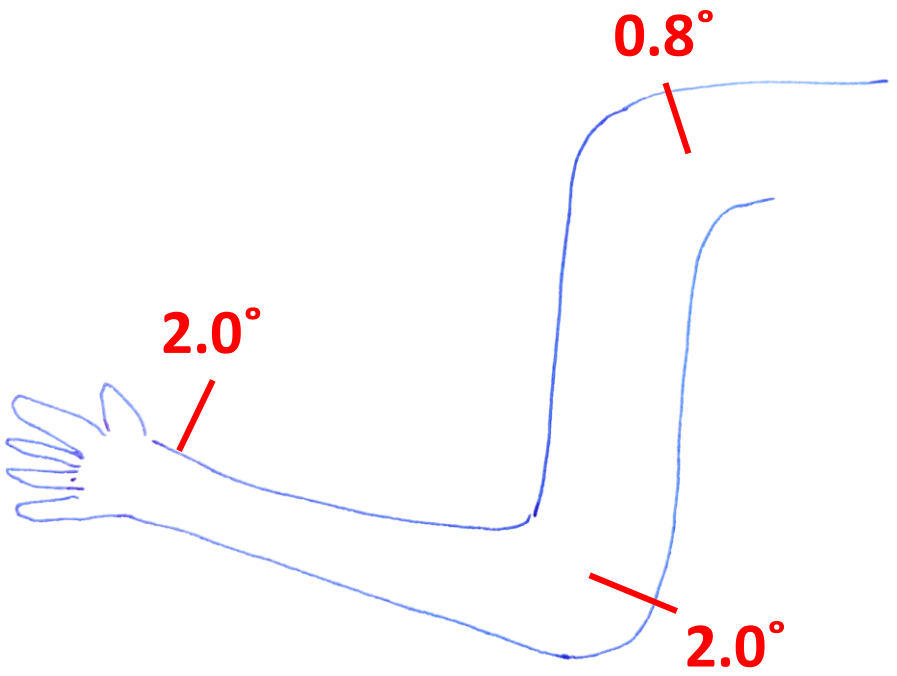
Kinesthetic Sensing

- Muscle receptors
  - Muscle spindles & Golgi tendon organs
- Joint receptors
  - Joint ligaments and capsules
- Skin receptors
  - Mechanoreceptors that measure skin stretch

Kinesthetic Sensing

- Force sensing resolution: 0.06 N (degrades as force increases)
- JND at Joints





Demo!

PseudoBend: Producing Haptic Illusions of Stretching, Bending, and Twisting Using Grain Vibrations

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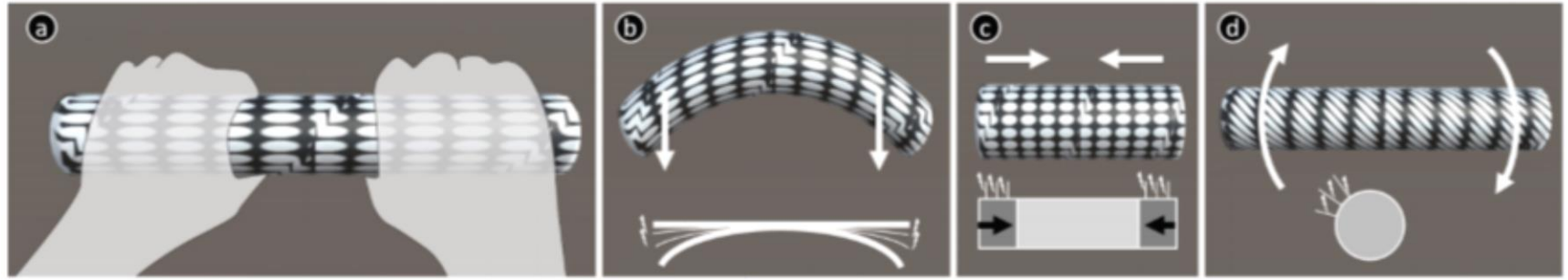


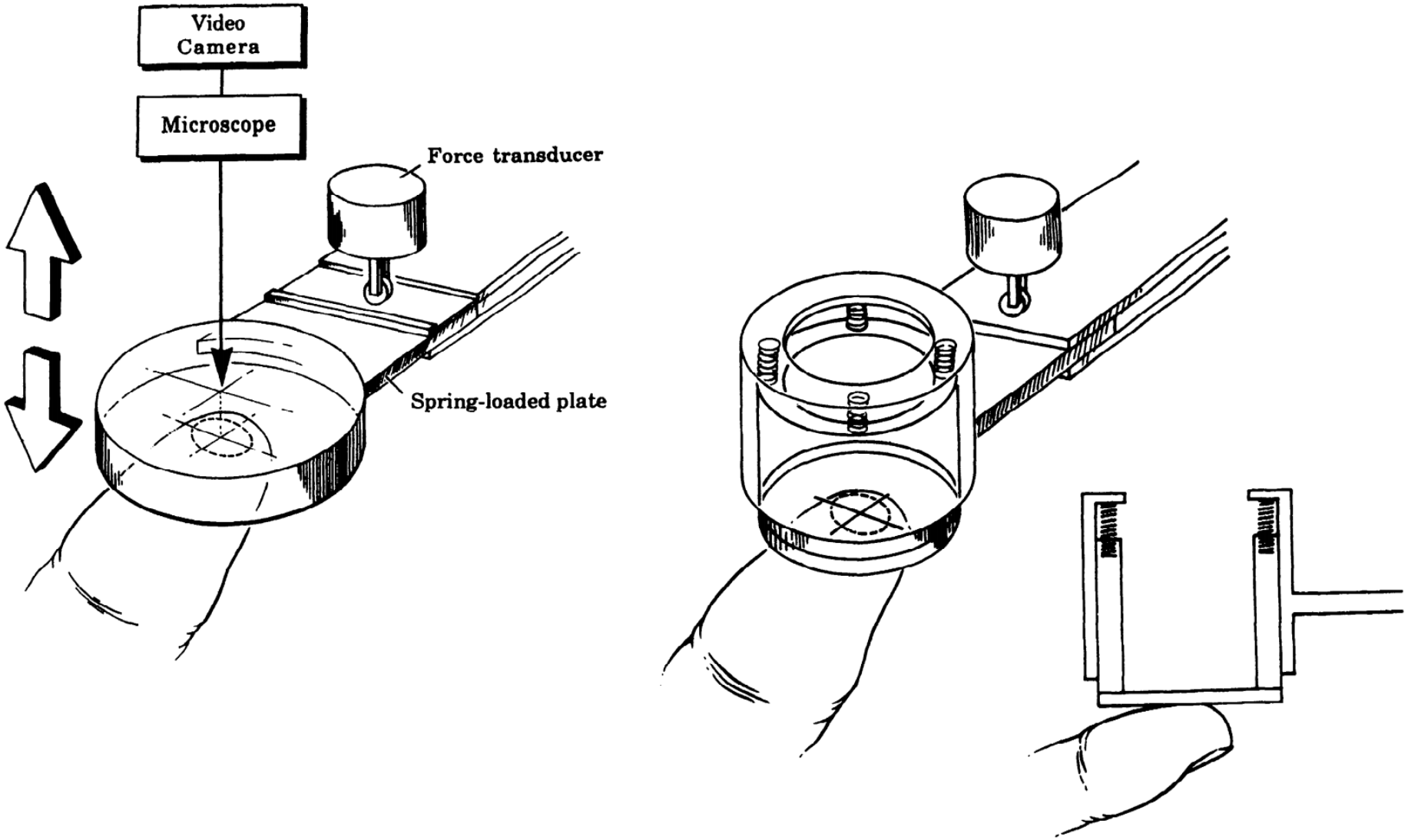
Figure 1. (a) The device is used with two hands. (b) Exerting downward torques with both hands relative to the center of the device bends the virtual model. (c) Forces inward, toward the center squeezes the model. (d) Two opposing torques twists the model. Frictional grain vibrations rendered when the changes of the shape of the virtual model exceed a threshold provides the illusion that the rigid device is being deformed.

ABSTRACT

We present PseudoBend, a haptic feedback technique that creates the illusion that a rigid device is being stretched, bent, or twisted. The method uses a single 6-DOF force sensor and a vibrotactile actuator to render grain vibrations to simulate the vibrations produced during object deformation based on the changes in force or torque exerted on a device. Because this method does not require any moving parts aside from the

INTRODUCTION

Many objects in the real world change their shapes when we push, pull, bend, or twist them. These objects have different shape-changing properties; how much force they need to change their shape (i.e., stiffness) or how they return to their original shape when the force is removed (i.e., elasticity). These properties are affected by the material and mechanical structure of the object, which can vary the shape-changing



M. A. Srinivasan and R. H. LaMotte, Tactual discrimination of softness,[SEP]Journal of Neurophysiology, vol. 73, no. 1, pp. 88–101, 1995

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Challenges in Haptics Research

- High-fidelity haptic rendering
- Mobile haptic interfaces
- Multimodal haptic devices
- Quantifying and sharing haptic experiences
- Generating haptic information

Thank you!