Human-machine interaction in virtual reality

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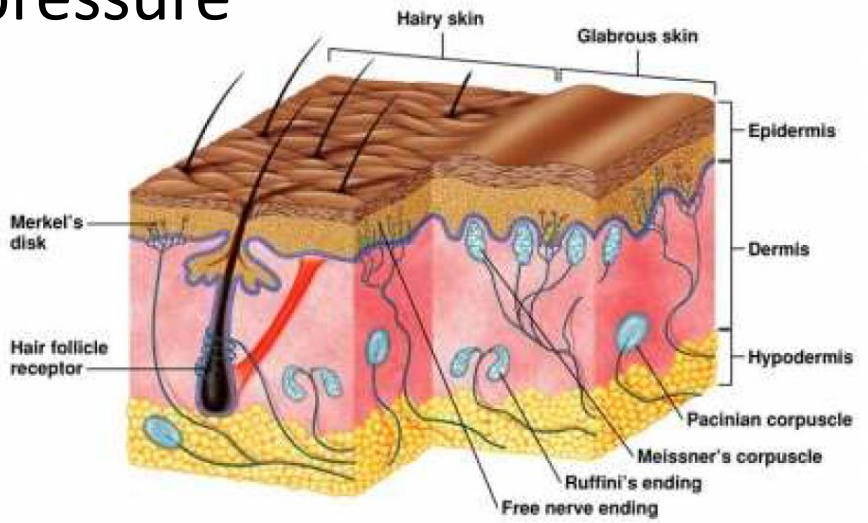
Frontiers

- 13.1: Touch and proprioception
- 13.2: Smell and Taste
- 13.3: Robotic interfaces
- 13.4: Brain-machine interfaces

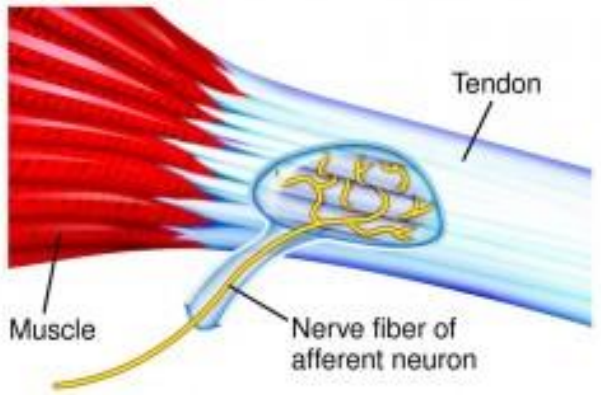
Somatosensory

- Receptors in the skin
  - Free nerve endings – pain
  - Ruffini's endings – stretch
  - Pacinian corpuscle – vibration
  - Merkel's disks – static pressure
  - Meissner's corpuscles
  - Hair follicle receptors



Propriocpetion

- Receptors in muscles, tendons
  - Muscle spindles
  - Golgi tendon organs
  - Joint receptors



Rendering in VR?

Haptic perception

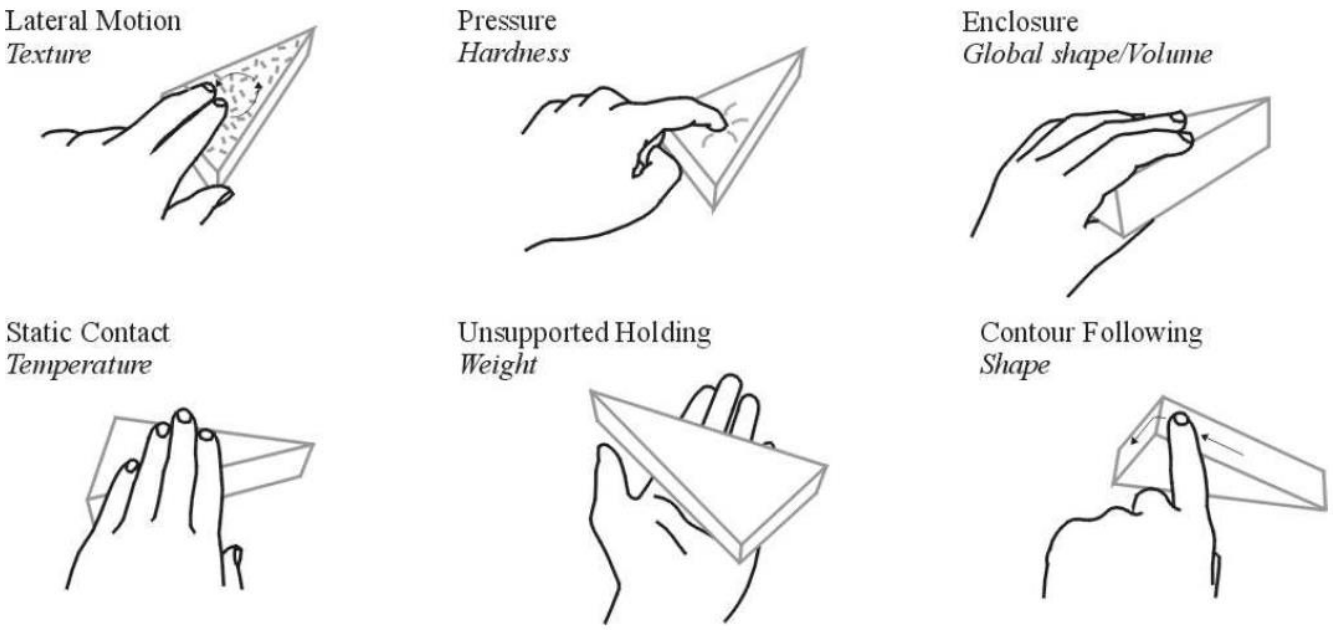


Figure 13.2: Haptic exploration involves several different kinds interaction between the hand and an object to learn the object properties, such as size, shape, weight, firmness, and surface texture. (Figure by Allison Okamura, adapted from Lederman and Klatzky.)

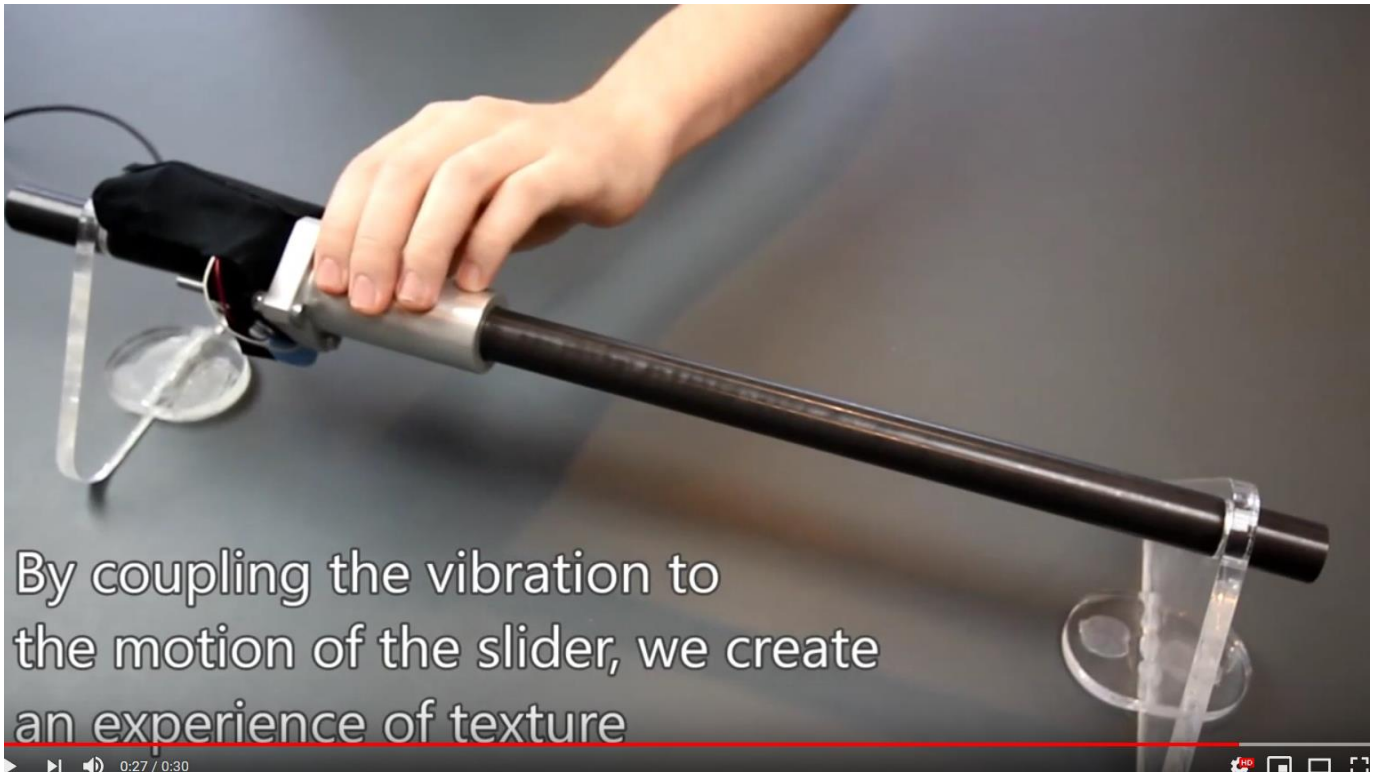
Recording Natural Stimulation

- We do not have knowledge to simulate these complex experiences

- But research is going in that direction
  - Video here
  - “Haptography” – recoding haptic/tactile stimuli

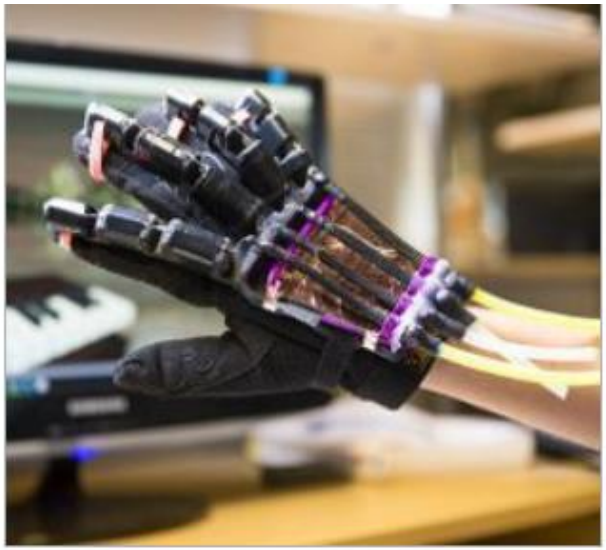
Texture simulation

- Link here



Haptic simulation

- Actuators for fingers and thumb



Haptic / tactile Interfaces

Interaction with Tools

- Well-suited for VR – introduces some separation between user and environment

Sword simulation

- Easier to simulate, but still resembles everyday interaction

Rubber Hand Illusion

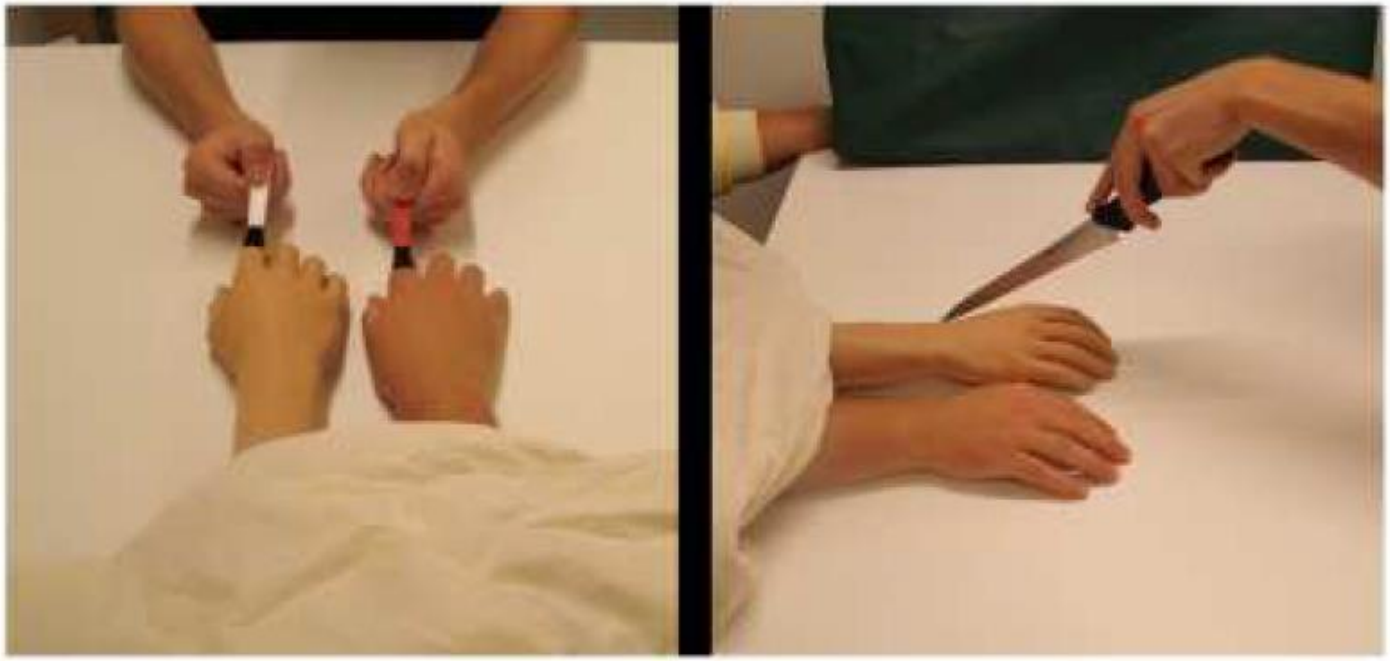


Figure 13.3: The *rubber hand illusion*, in which a person reacts to a fake hand as if it were her own. (Figure from Guterstam, Petkova, and Ehrsson, 2011 [108])

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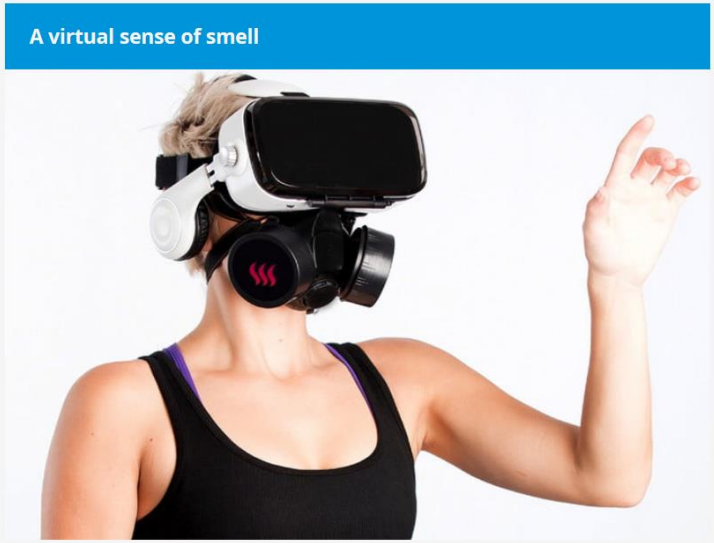
Taste and smell

- Gustation and olfaction
- Relies on chemoreceptors

- Taste dimensions:
  - Sweet
  - Sour
  - Salty
  - Bitter
  - Umami

VR for taste and smell

- Article here



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Avatar Mechs

Teleoperation

- Controlling robots remotely
- Control actions lead to sensory feedback for the user
- Examples:
  - Flying drones
  - Remote surgery
  - Controlling a lunar or mars rover or undersea robot

Telepresence

- Feeling present in the remote environment
- Like VR presence, but the remote environment is real, not virtual
- Hindered by:
  - Remote sensing capabilities
  - Remote action capabilities
  - Communication latency
  - Display quality

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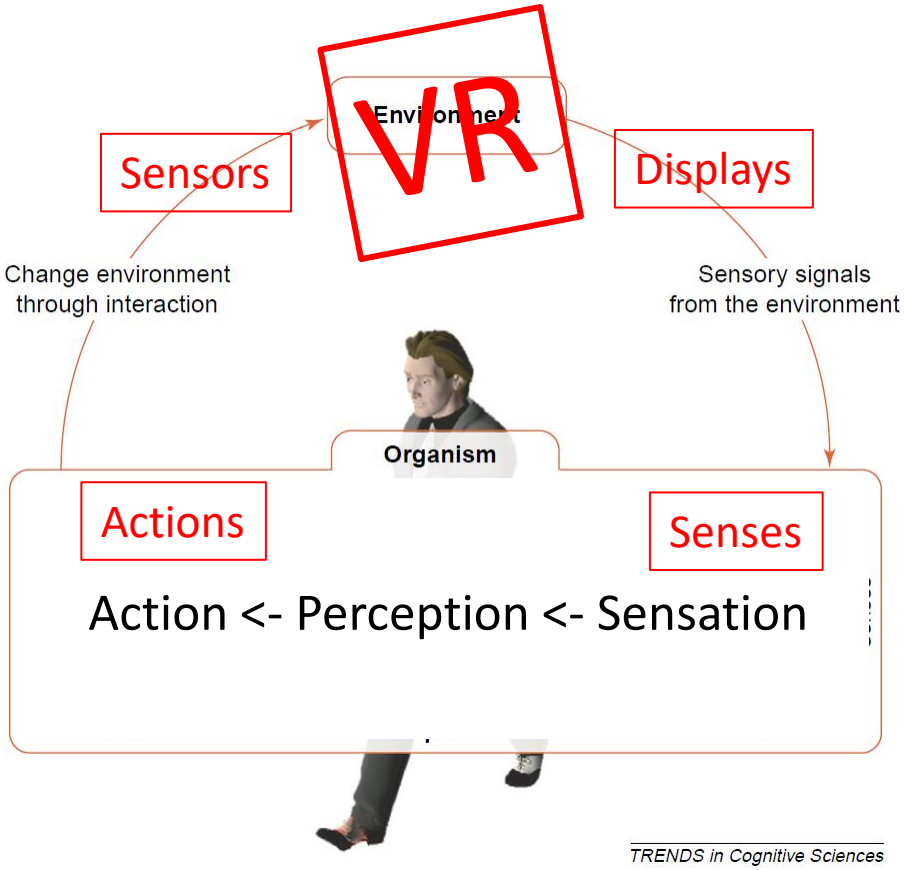
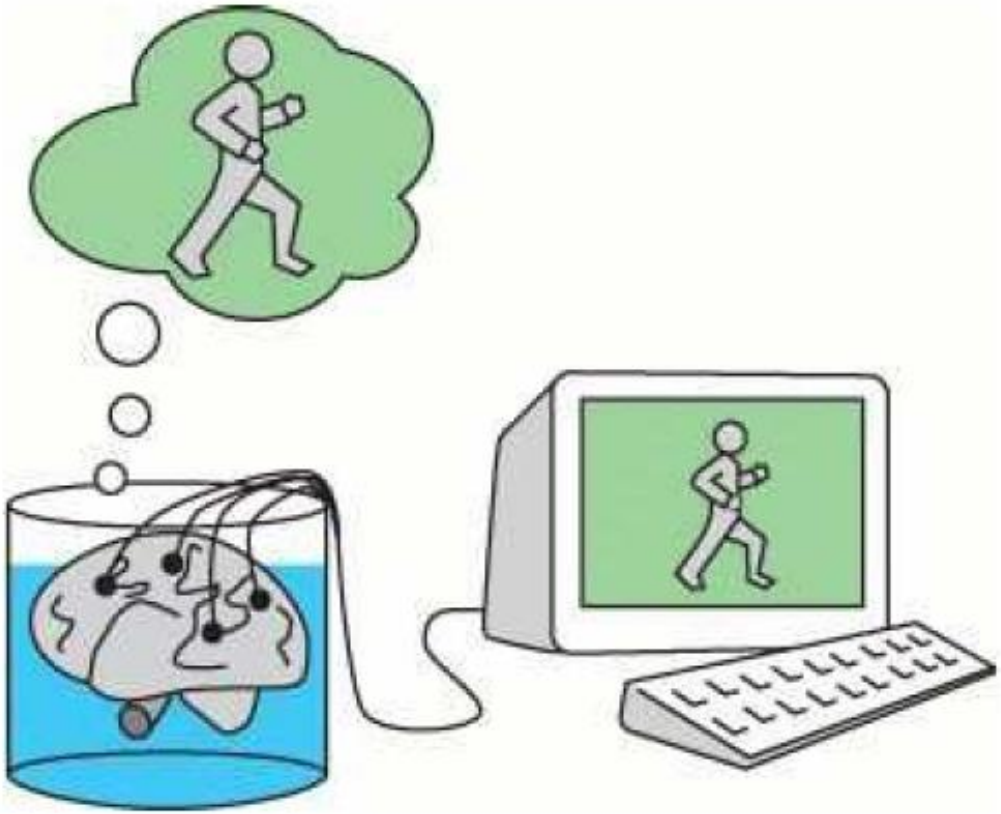
Bypassing the body



The Brain in a Vat



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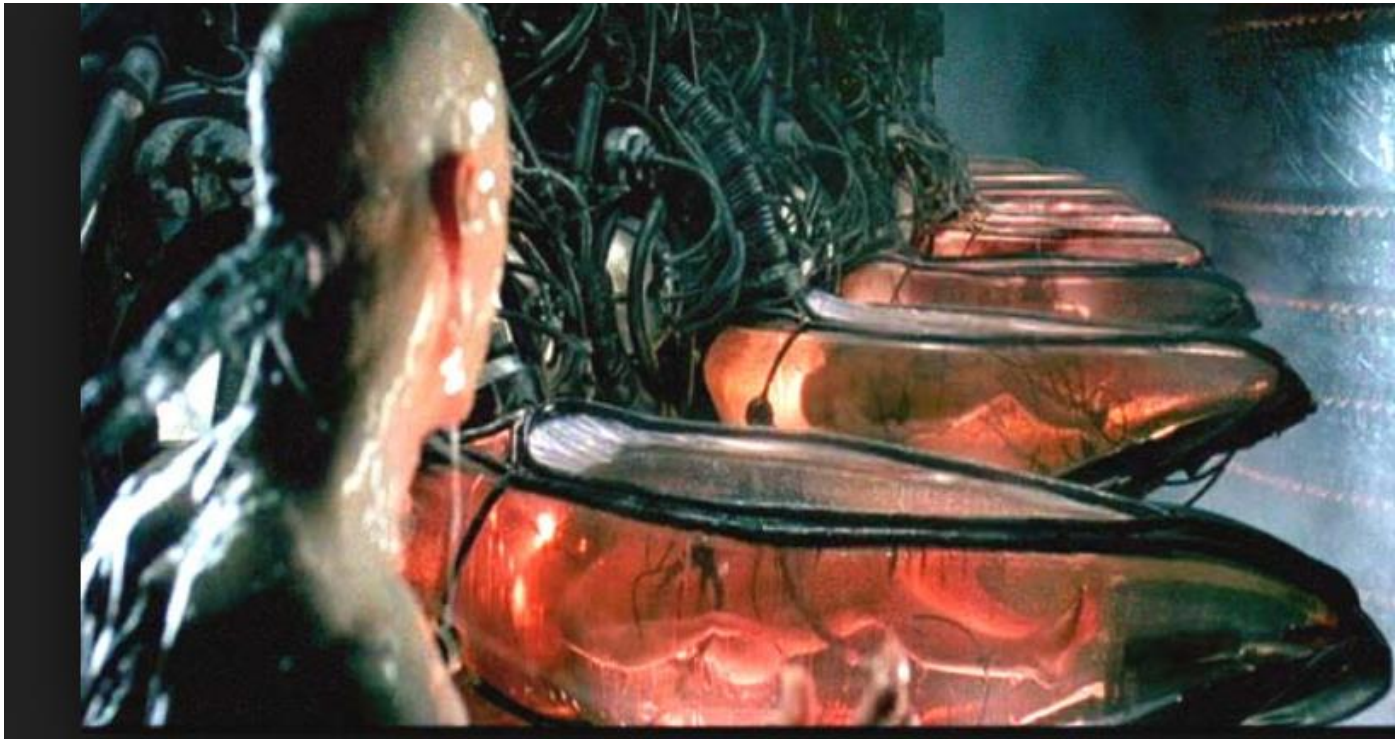

Brain-machine Interface

- Mental control of robotic arm
  - Video here