Why can't you tickle yourself?

Touch receptors

- Last time we talked about the mechanoreceptors involved touch perception
- It is important to remember that touch is a percept that fundamentally is created by the brain
- Consider phantom limbs
- Referenced in *Moby Dick* by Captain Ahab
  - Look ye carpenter, I dare say thou callest thyself a right good workmanlike workman, eh? Well, then, will it speak thoroughly well for thy work, if, when I come to mount this leg thou makest, I shall nevertheless feel another leg in the same identical place with it; that is, carpenter, my old lost leg; the flesh and blood one, I mean. Canst thou not drive that old Adam away?
Phantom limbs

- Estimates are that between 50-80% of amputees suffer from some form of phantom limb
- Here's a description by neuropsychologist Ramachandran (1998)
  - As a result of this gruesome mishap [a motorcycle accident], Tom lost his left arm just above the elbow...In the weeks afterward, even though he knew his arm was gone, Tom could still feel its ghostly presence below the elbow. He could wiggle each “finger,” “reach out” and “grab” objects that were within arm’s reach. Indeed, his phantom arm seemed to be able to do anything that the real arm would have done automatically, such as warding off blows, breaking falls or patting his little brother on the back.

Brain representation

- The brain does not represent all areas of the body equally
- Some areas (such as fingertips) have many mechanoreceptors with small receptive fields
- Other areas (such as the back) have few mechanoreceptors with large receptive fields
- Two-point thresholds reveal these differences
  - Larger thresholds mean less sensitivity
Brain representation

- Neural fibers for touch go through several intermediate areas (spinal cord, thalamus, medial lemniscus) and then reach the parietal lobe of the cortex.

![Brain representation diagram]

Somatotopic representation

- In the somatosensory cortex, neighboring neurons tend to respond to touch from neighboring parts of the body.
  - It’s not perfect, though, there are some gaps.
  - There are multiple maps for parts of the body, running along strips from top to bottom of the somatosensory area.

![Somatotopic representation diagram]
Somatotopic representation

- Areas of the body are not represented equally in cortex
- Size of drawn body area indicates the number of cells that respond to touch at that location
- Note, your textbook has the head representation upside down!
- Note, the genitals are just below the feet
  - Every wonder why playing “footsie” is arousing?

Somatotopic homonculus

- Useful to make a 3-D representation of the body maps
- Again, the size of the body part indicates the amount of brain area dedicated to responding to touch at that area
- Compare to the two-point touch thresholds and you’ll see that there is pretty good correspondence
  - Lower thresholds are for those areas with more brain area representation
Phantom limbs

- The structure of somatosensory cortex partially explains some aspects of phantom limbs
- Before amputation, a person’s brain might be organized like this

Phantom limbs

- The structure of somatosensory cortex partially explains some aspects of phantom limbs
- After arm amputation, the brain starts to re-organize
- The region that used to respond to the fingers, starts to respond to touch from the face
Phantom limbs

- For some people with phantom limbs
- A touch on the face is felt as a touch on the phantom limb
- You can map out a map of the phantom limb on the face of the person

Tickling

- Tickling is an odd sensation
  - Both pleasure (laughter)
  - And pain (a method of torture in Roman times)
  - Similar to sexual stimulation
- It is almost impossible to tickle yourself
  - Try it on the palm of your friend
  - If you are comfortable with it, ask your neighbor to tickle you in the same spot
- Note the difference in sensation
  - Even though the same mechanoreceptors respond about the same
  - The difference is in the brain
Sorting out sources

- We need to be able to distinguish event in the environment from self-induced events
  - Think of corollary discharge for eye movements
  - Same issue for touch
- For the motor system, we call it an “efference copy”
  - It produces a predicted touch sensation

Self-tickling

- When we try to self-tickle, the predicted sensory feedback is similar to the actual sensory feedback, and the sensory feedback is filtered out
- When someone else tickles us, we don’t have the predicted sensory feedback, so the sensation is stronger
Tickling machine

- To study anything you need to be able to reproduce the stimulus
- This is a tickling machine
  - It can be run by a person or a computer
- If run by the person being touched, it does not produce a tickle
  - Unless the motion of the machine is delayed unpredictably

Pain perception

- Complex perceptual experience
- Warning of biological damage
  - But not always, often people do not feel pain until after they recognize the damage
- Experience of pain depends tremendously on
  - The instigating condition
  - The person’s history with pain
  - The person’s mental state
- Many aspects of pain are related to a class of receptors known as nociceptors
  - Found among free nerve endings in the skin, eye, teeth, and some internal organs
Nociceptors

- Here are shown free nerve endings in the skin
  - They are less sensitive to stimuli than other mechanoreceptors for touch or temperature

There are several types of nociceptor fibers
- Myelinated (fast)
- Unmyelinated (slow)

- Fast-conducting fibers
  - Respond to
    » strong mechanical stimulus (a pin prick)
    » Thermal stimulation (intense heat)
  - Produce a sensation of sharp acute pain

- Slow-conducting fibers
  - Respond to
    » Mechanical and thermal stimulation
    » Chemical stimulation (acid on the skin)
  - Produce slow-growing sensation for pain that can be long-lasting
Gate control theory

- The responses from nociceptors do not always reach the brain
  - They are gated by a variety of other inputs
- There is a circuit in the spinal cord that looks something like this

Suppose you touch the handle of a pan that is at room temperature
- The large fibers are activated
- They active both the interneuron and rho
- But the interneuron inhibits rho, so no pain
Gate control theory

- Suppose you touch the handle of a pan that is hot enough to activate the nociceptors
  - The large fibers are activated, they activate both the interneuron and rho
  - The small fibers are activated, they inhibit the interneuron and activate rho
  - The balance of activity is for rho to respond so you feel pain

Gate control theory

- This explains why you rub a spot that is in pain
  - It increases activation of the touch mechanoreceptors, which inhibits the interneuron, which reduces pain
- It also explains why massage provides (at least short-term) relief of pain
Gate control theory

- Also provides a plausible mechanism for other types of control of pain
- Pain is modulated by things that cannot possibly affect the nociceptors
- Placebo effects
- Knowledge of what to expect from surgery
- The meaning of the pain
  - E.g. if you believe it can damage tissue (such as a very hot piece of metal), it hurts more when it touches you

Conclusions

- Phantom limbs
- Brain organization
- Tickling
- Pain perception
  - Much more complicated than we have discussed
Next time

- Switch to discussion of olfaction
- Sense of smell