Skin Senses: Touch, Haptics, Nociception, Vestibular System
Receptors

- The receptor cells in the skin are (mostly) called **mechanoreceptors**, and *transduce mechanical force*.
  - Mechanical force is any kind of physical prodding, pushing, stretching, pulling, etc.
  - Most of these cells live a little ways under your skin in the *dermis*, the second layer of skin (unlike the *epidermis*, which consists of dead cells, the dermis is alive.)
• Mechanoreceptors (cont.)
  • There are two main varieties of mechanoreceptor:
  • *Slowly adapting* mechanoreceptors continue to fire for a long time, as long as they are continually being stimulated.

  ![Graph of Slowly adapting (SA)](image)

  • *Rapidly adapting* mechanoreceptors fire only briefly, right after a stimulus disturbs the skin, and then stop firing.

  ![Graph of Rapidly adapting (RA)](image)
• Mechanoreceptors (cont.)
  • Each mechanoreceptor has a *receptive field*, that region of skin that may activate the receptor if stimulated.
  • With more receptor cells, there are smaller receptive fields, and with few receptor cells, there are larger receptive fields.
  • Receptor cells project into the spine, and up into the brain.
  • The brain has a particular region, the *somatosensory cortex*, devoted to processing touch input.
Mechanoreceptors (cont.)

Somatosensory cortex (cont.)

Regions on your skin are mapped into S.C., so that, if a place on your skin is touched, you'll see activation in the corresponding region of S.C.

The critter drawn on the left around the brain is referred to as a homunculus ("little man").
• Mechanoreceptors (cont.)
  • Somatosensory cortex (cont.)
    • S.C. is *topographically mapped*. This means that (most of the time) points near each other on your skin are near each other in S.C.
• Regions on your skin that have high receptor density (and hence large amounts of somatosensory cortex devoted to them) will be sensitive to a *two-point acuity test*.
• Two-point acuity test: using calipers, pins, or toothpicks (or something) stimulate two points on a participant's skin. Can the participant tell it's two points? If not, the two points are below threshold.
Kinesthesis, Haptic perception

- Kinesthesis is the perception of whether your body is moving or stationary, as well as the perception of how your limbs are arranged when you can't see them.
- Your sense of kinesthesis (often called proprioception) comes from muscle spindle cells located in muscles and joints.
- These spindle cells are stretched by movement; the stretching causes neural firing.
- Spindle cells then project into the spine, and then the brain.
**Kinesthesia, Haptic perception (Cont)**

- “Pride and a Daily Marathon”
  - Ian Waterman, at age 19, lost his sense of proprioception (and light touch) due to a viral infection.
  - Initially, he collapsed to the floor, unable to move. Although the neurons never recovered, over the course of years he taught himself to use vision as a replacement for proprioception – he can walk unaided.
  - Still, if the lights go out unexpectedly (depriving him of his sense of vision), he collapses to the floor.
• **Kinesthesia, Haptic perception (Cont)**
  • Haptic perception: the combination of touch and kinesthesia that allows us to identify objects.
  • Exploration of three-dimensional objects with the hand (either via touch or *wielding*).
  • *Tadoma*: method of speech perception using only hands placed on “articulators:” lips and neck.
Kinesthesia, Haptic perception (Cont)

**Wielding**: you can perceive certain object properties simply by holding and moving an object.
• Nociception and pain
• What is pain?
  • It's complicated
  • “Unpleasant sensory and emotional experience associated with actual or potential tissue damage.” (Merskey, 1986)
• Often useful because it tells you when you're in some kind of danger. (Melzack and Wall, 1988: a woman born without a well-functioning sense of pain dies at age 29 because she had not detected various injuries that then became infected.)
• Nociception and pain
  • Pain receptors (nociceptors) are free nerve endings in the skin (in epidermis and subcutaneous fat)
  • Pain can also occur when normal skin receptors fire and the central nervous system pain pathways respond (as a result of injury or disease)
  • For example, phantom limb pain: perceived pain in an amputated arm or limb
• Nociception and pain
• Top-down influences on pain
• Placebo: people report relief from pain after taking only a sugar pill, if they believe it's morphine – probably works because your body can produce endogenous opiates (Petrovic, et. al. 2002)
• Acupuncture: long needles inserted into different sites on the body. Don't directly interfere with nociceptors. Seems to be effective (Mamtani and Cimino, 2002). Also probably releases opiates
• Nociception and pain
• Top-down influences on pain
  • expectation: Weisenberg, 1977. Surgical patients
    • gp 1: told what kind of pain to expect, instructed to relax to alleviate pain.
    • gp 2: no info.
• result: gp 1 left hospital 2.7 days earlier, and requested fewer painkillers.
• Nociception and pain
  • Top-down influences on pain
  • *emotional distraction*. deWeid & Verbaten (2001). 3 gps (all males)
  • gp 1: view positive pictures – attractive women, sports, etc.
  • gp 2: view neutral pictures – household objects, nature scenes, people.
  • gp 3: view negative pictures – burn victims, accidents
• Nociception and pain
  • All three groups immersed hands in 2± C water, told to withdraw hand when it began to hurt.

• results:
• orientation perception
• *vestibular system* – for perceiving orientation and acceleration.
• simple invertebrate system:
• orientation perception
• vestibular system

• Human vestibular system is similar.
• orientation perception

• vestibular system

• Depends on saccule, utricle, semicircular canals, located in inner ears.

• *saccule* – recognize motion up–down

• *utricle* – recognize front–back or left–right

• *Semicircular canals* – three canals are located in different planes (think depth, width, height); allows recognition of rotation in any of three directions.
- Orientation perception
- Vestibular system
- Semicircular canals
- Cupula

Fluid in the canals can push the cupula in different directions.
• orientation perception
• vestibular system
  • *compensatory eye movements*. nerve fibers go from canals to eye muscles. result in eye movements in opposite direction of rotation – helps keep eyes focused on an object fixed in space while rotating.
• dizziness *from alcohol*: alcohol gets into cupola, alters density of liquid inside.
• orientation perception
• vestibular system
  • *Motion sickness*: motion information signaled by vision is not matched with motion information signaled by vestibular sense.
• Occurs more for up–down movements.
  • shutting your eyes is a fair way of dealing with the problem.
• Wrist–bands, magnets, etc. seem not to work, except as placebos.
• Dramamine, meclizine are effective ways to prevent motion sickness
<table>
<thead>
<tr>
<th>Term</th>
<th>Term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transduction</td>
<td>Nociceptors</td>
</tr>
<tr>
<td>Mechanoreceptors</td>
<td>Phantom limb pain</td>
</tr>
<tr>
<td>Dermis</td>
<td>Top-down influences on pain</td>
</tr>
<tr>
<td>Epidermis</td>
<td>Placebo</td>
</tr>
<tr>
<td>Slowly adapting mechanoreceptors</td>
<td>Acupuncture</td>
</tr>
<tr>
<td>Rapidly adapting mechanoreceptors</td>
<td>Expectation</td>
</tr>
<tr>
<td>Receptive field</td>
<td>Emotional distraction</td>
</tr>
<tr>
<td>Somatosensory cortex</td>
<td>Vestibular System</td>
</tr>
<tr>
<td>Topographic mapping</td>
<td>Statolith</td>
</tr>
<tr>
<td>Two-point acuity test</td>
<td>Saccule</td>
</tr>
<tr>
<td>Kinesthesia, haptic perception</td>
<td>Utricle</td>
</tr>
<tr>
<td>Muscle spindle cells</td>
<td>Semicircular canals</td>
</tr>
<tr>
<td>Pride and a Daily Marathon</td>
<td>Cupula</td>
</tr>
<tr>
<td>Tadoma</td>
<td>Compensatory eye movements</td>
</tr>
<tr>
<td>Wielding</td>
<td>Dizziness from alcohol</td>
</tr>
<tr>
<td>nociception</td>
<td>Motion Sickness</td>
</tr>
</tbody>
</table>