COGS 101A: Sensation and Perception

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UCSD

Lecture 16:

Recurring Themes, Somatosensory system

Course Information

- Class web page: http://cogsci.ucsd.edu/ desa/101a/index.html
- Professor: Virginia de Sa
  - ⋆ I'm usually in Chemistry Research Building (CRB) 214 (also office in CSB 164)
  - ⋆ Office Hours: Monday 5-6pm
  - ⋆ email: desa at ucsd
  - ⋆ Research: Perception and Learning in Humans and Machines

For your Assistance

TAS:

- Jelena Jovanovic OH: Wed 2-3pm CSB 225
- Katherine DeLong OH: Thurs noon-1pm CSB 131

IAS:

- Jennifer Becker OH: Fri 10-11am CSB 114
- Lydia Wood OH: Mon 12-1pm CSB 114

Course Goals

- To appreciate the difficulty of sensory perception
- To learn about sensory perception at several levels of analysis
- To see similarities across the sensory modalities
- To become more attuned to multi-sensory interactions

Grading Information

- 25% each for 2 midterms
- 32% comprehensive final
- 3% each for 6 lab reports - due at the end of the lab
- Bonus for participating in a psych or cogsci experiment AND writing a paragraph description of the study (just a few sentences) Deadline to sign up for experiments on Experimetrix has passed
- New lenient midterm policy: If you do better on the final than your worst midterm, we'll downweight that midterm to 10% (and upweight the final); If you do better on the final than your best midterm, we'll downweight that midterm to 15%. There will be no downweighting of the final. We will also drop your lowest lab grade IF you complete all labs

You are responsible for knowing the lecture material and the assigned readings. Read the readings before class and ask questions in class.

Academic Dishonesty

The University policy is linked off the course web page.

You will all have to sign a form before each test

For this class:

- Labs are done in small groups but writeups must be in your own words
- There is no collaboration on midterms and final exam

Midterm 2

Congratulations! Generally grades are very high.

Mean 80%

Low 46%

High 100%

Principles of Auditory Grouping

auditory stream segregation - the separation of auditory signals into separate perceptual streams

(compare with principles of visual grouping)

location- sounds created by one source come from one location or a slowly changing location

similarity of timbre- sounds that have the same timbre are often from the same source (auditory stream segregation of sounds with different timbres)

Principles of Auditory Grouping (cont'd)

similarity of pitch- sounds with the same frequency are often produced by the same source (auditory stream segregation of high and low sounds)

- **implied polyphony**-rapidly alternating high and low notes are perceived as two separate instruments go to Segregation of high notes in a Telleman Sonata

Principles of Auditory Grouping (similarity of pitch cont'd)

- **scale illusion** or **melodic chanelling**

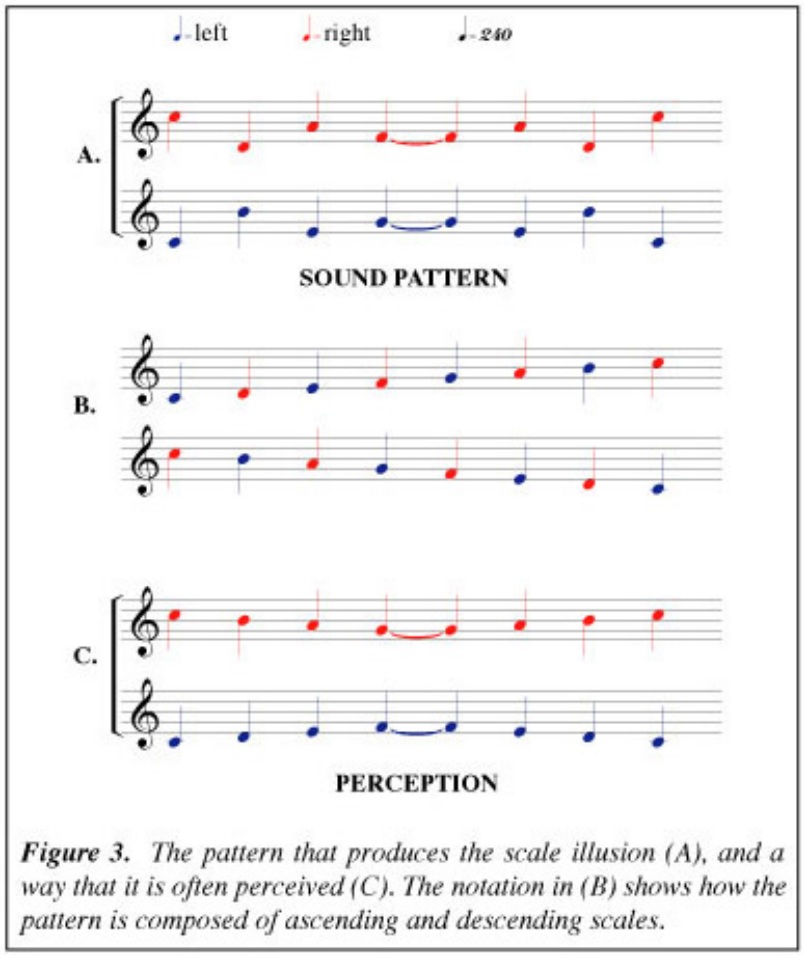


Figure 3. *The pattern that produces the scale illusion (A), and a way that it is often perceived (C). The notation in (B) shows how the pattern is composed of ascending and descending scales.*

http://psy.ucsd.edu/ ddeutsch/psychology/deutsch_research3.html Scale Illusion

page

Principles of Auditory Grouping (similarity of pitch cont'd)

- Bregman and Rudnicky experiment -It is difficult to judge the order of two tones when there are distractor tones. But the distractor tones can be more easily ignored when they are part of another group (see Figure 11.25 in your textbook) go to Grouping by Similarity of Pitch

Principles of Auditory Grouping (cont'd)

temporal proximity sounds that occur close together in time tend to come from the same source

- go to Effect of Temporal proximity on Stream segregation and Grouping by Pitch and Temporal Closeness and Grouping of noise pitch and temporal closeness

onset and offset sounds that stop at start at different times tend to be produced by *different* sources

good continuation sounds that stay constant or change smoothly are often produced by the same source.

- Listeners hear a sound continuing behind noise go to Auditory Good Continuation and Auditory Good Continuation for Speech

Experience -

- Tend to group things that you have heard together in the past go to Effect of repetition on grouping by pitch

- When you know what to listen for you can hear it even when it has intervening noise notes or when the notes are transcribed to random octaves go to Perceiving a melody obscured by noise – This also illustrates grouping by frequency

Somatosensory (touch) System and General Principles of sensory systems

We will present the somatosensory system by referring to general principles of all sensory systems (and give examples from the somatosensory system).

Many thanks to Chris Johnson for her outline. (The lecture follows closely the format of Chris Johnson's notes.)

Tutis Vilis' notes

Somatosensory system

Cutaneous sensations - touch

Proprioception - sense of limb position

Kinesthetics - sense of limb movement

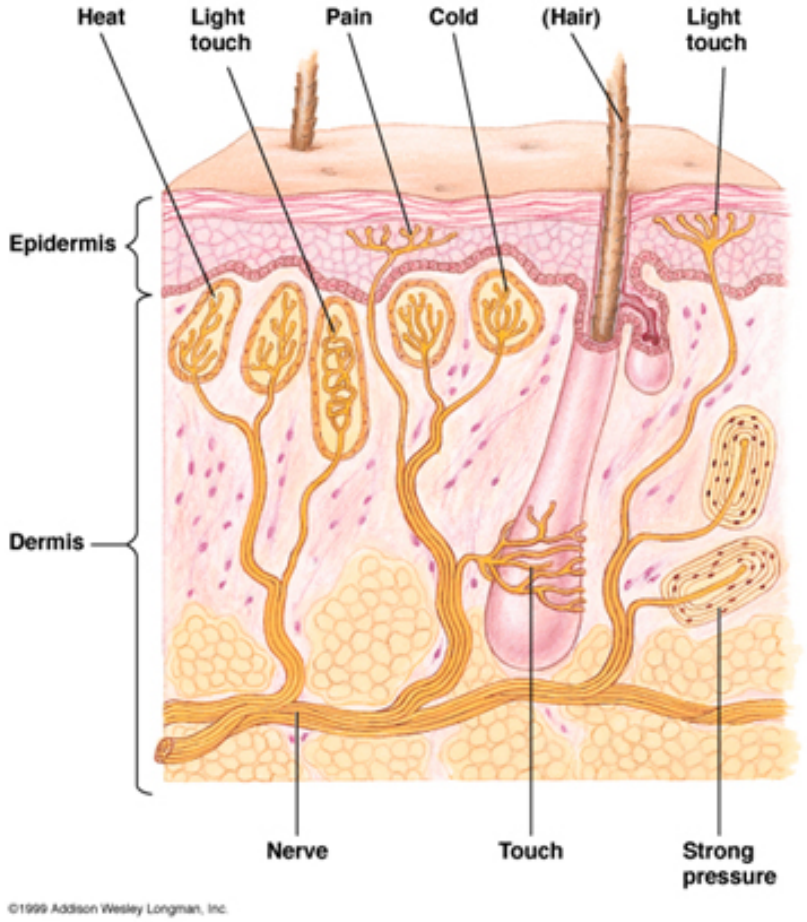
Receptors

Receptors transduce the sensory signal

There are 4 different types of touch receptors that are sensitive to different types of touch (compare with different types of photoreceptors)

Touch receptors

(see Figure 13.2/13.3 in the text) some (but not Ruffini cylinder) are shown below)



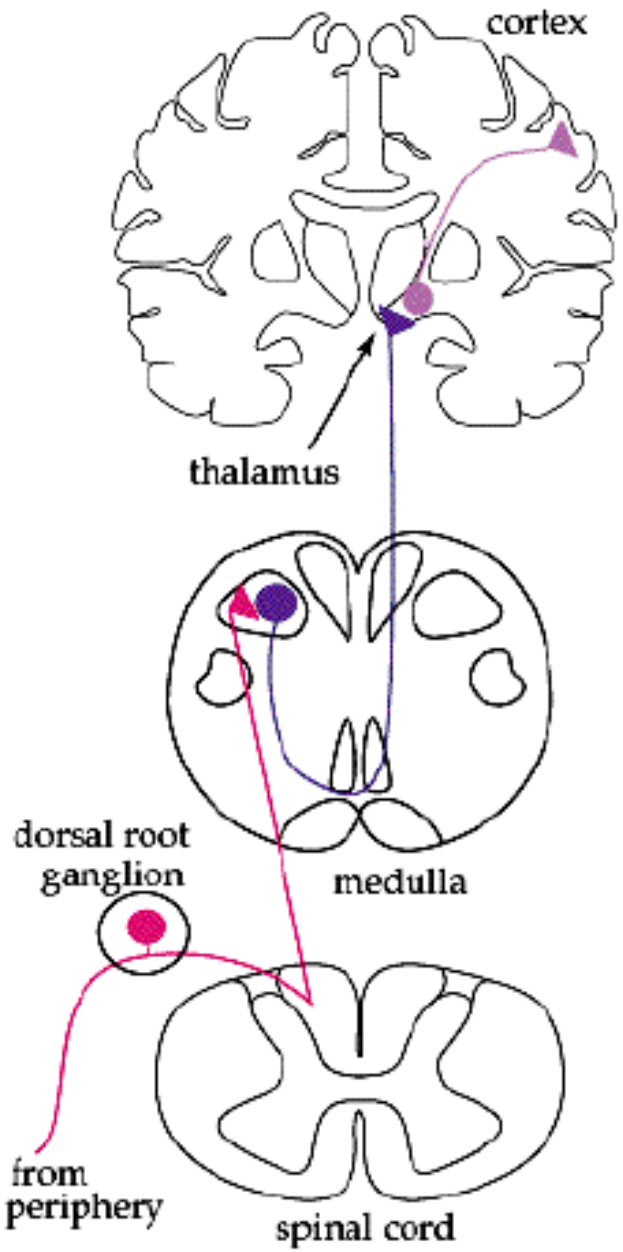
http://fig.cox.miami.edu/ cmallery/150/neuro/senses.htm

Pathways

Before cortex, the somatosensory pathway goes through the thalamus (Ventral Posterior Nucleus of the Thalamus (VPN))

One side of the body is represented in the contralateral VPN (and contralateral S1, S2) (The thalamus projects ipsilaterally to cortex)

Somatosensory Pathway



http://thalamus.wustl.edu/course/bassens.html

Coding: Connectivity, Receptive Fields, Acuity and Sensitivity

Two of the four receptor types are **rapid adapting** - they give a transient response to sustained stimulation (like magno cells)

The other two are **slow adapting** (like parvo) - they give a more sustained response to prolonged stimulation

Two have small receptive fields and two have large receptive fields

	Small RF (1:1) High Acuity	Large RF (Many:1) Low Acuity
Rapid Adapting	RA1 or Meissner's Corpuscles	RA2 or Pacinian Corpuscles
Slow Adapting	SA1 or Merkel's Discs	SA2 or Ruffini endings

Meissner's are found very near the surface and respond best to changing details giving a perception of flutter

Merkel's are near the surface and respond best to unchanging detail (pressure)

Ruffini's are found deep in the skin and respond best to unchanging gross movement (stretching)

Pacinian are found deep in the skin and muscles and respond best to changes in gross movement (vibration)

These different neuron types take different pathways to cortex **labeled lines** (as if a label is attached to fiber saying what type of receptor it came from)

Population coding and selective adaptation

For temperature sensation we have two types of **thermoreceptors warm-best** (respond to warming and static warm temps that are warmer than body temperatures) and **cool-best** (respond to cooling and static cool temps that are cooler than body temp).

The range of temperatures that each type respond to overlaps with that of the other type.

Perception of temperature involves looking at the distribution of activity across both receptor types.

Adapting to warm will give an aftereffect of cooler

Lateral inhibition

Neurons in VPN have center-surround receptive fields

Also the "gate theory" of pain control has non-painful tactile stimuli inhibiting the propagation of activity from pain stimuli

Negative Feedback

Negative feedback - decrease the activity that led to the stimulation

e.g. Pain withdrawal reflex - There is a spinal reflex that causes you to withdraw from painful stimuli (note this is a pull back of the hand, so when you burn the top of your hand on the oven, this reflex works against you!)

(compare with feedback to muscles in middle ear)

Topological cortical maps

Topological maps preserve the spatial relationships that exist between receptors.

Visual cortex is retinotopic

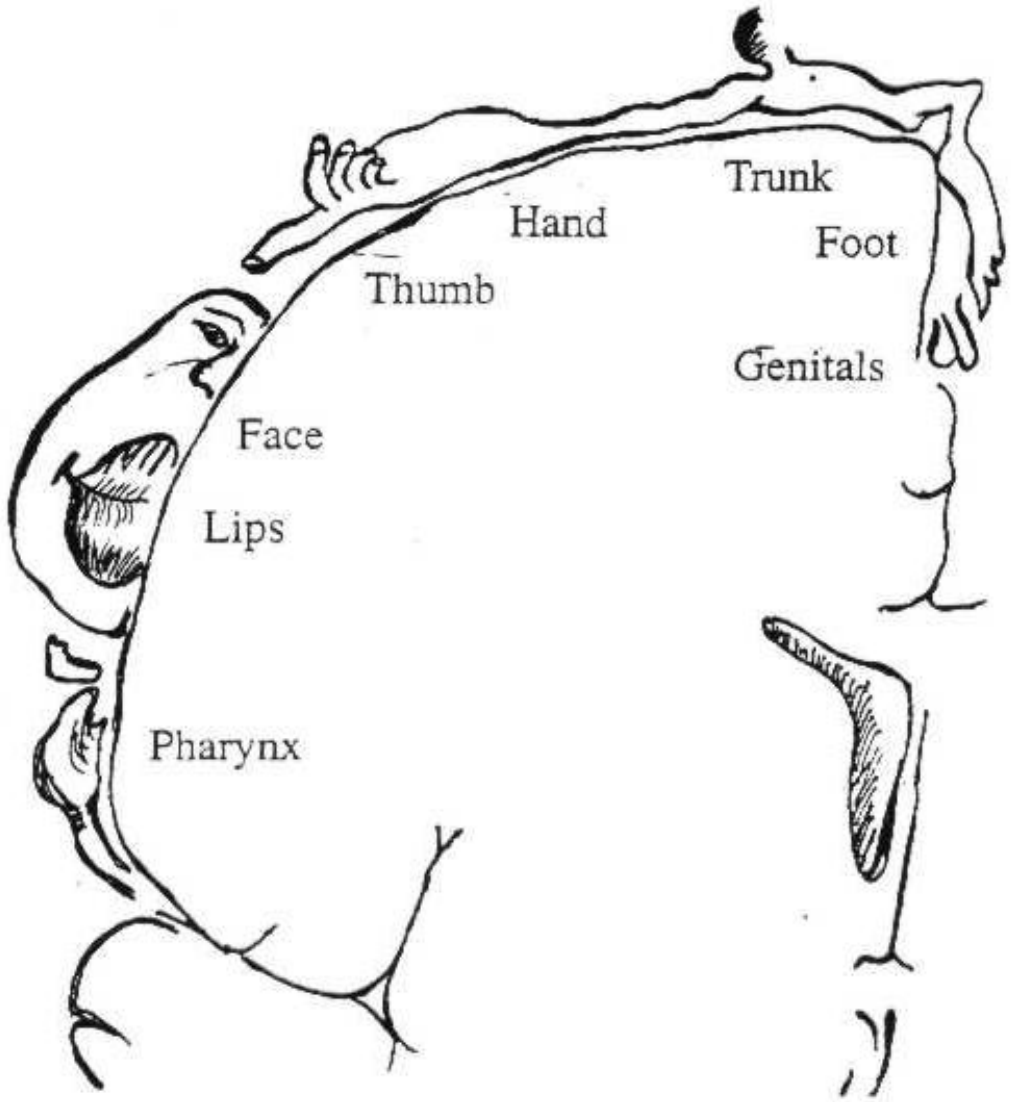
Auditory cortex is tonotopic

Somatosensory cortex is somatotopic (the drawn body area is often called a "homunculus")

Areas with a high density of receptors (with small receptive fields and little convergence) will have a greater area of the cortical map. For touch: the mouth, tongue, and hands have a greatly magnified representation in the homunculus.

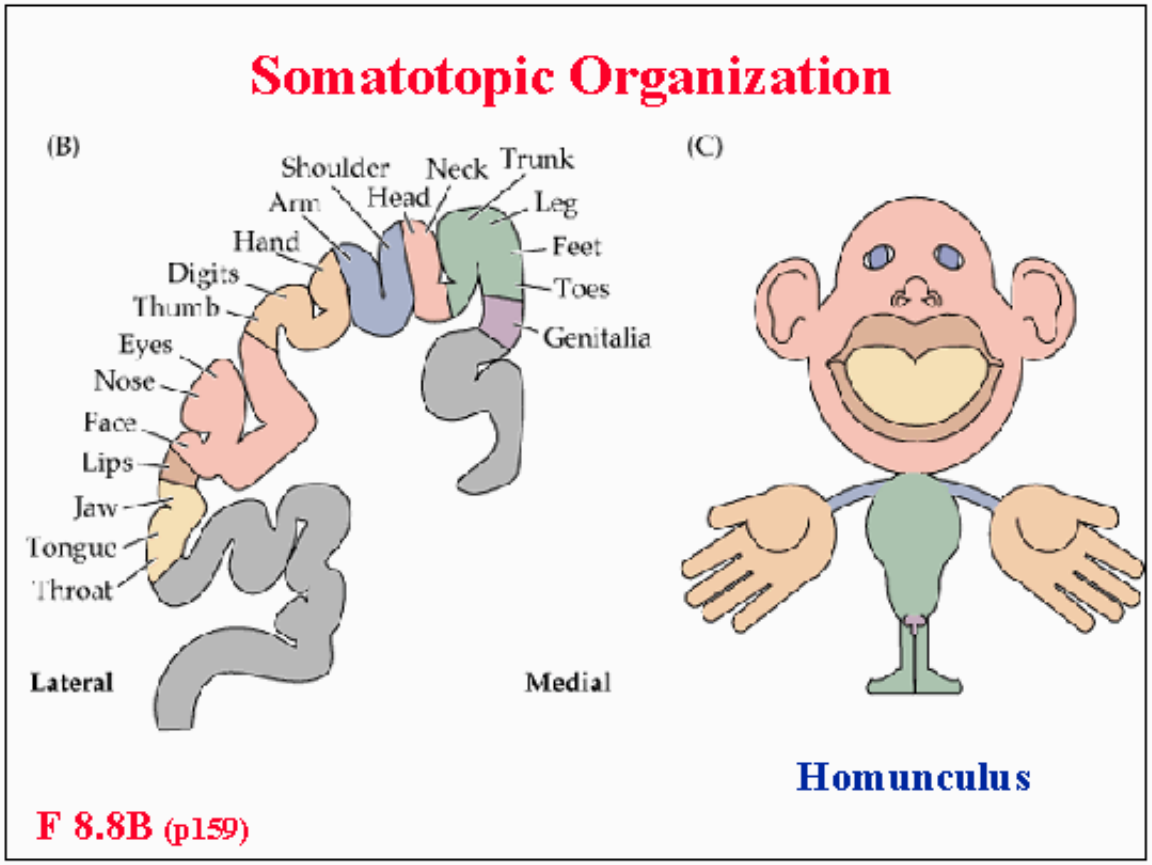
The **two-point thresholds** will be smaller where there are smaller receptive fields

Somatotopic Map



http://zeus.rutgers.edu/ ikovacs/SandP/fig5.jpg Note according to Tutis Vilis, the head should be upside down. (This is also wrong in the textbook)

Somatotopic Map



http://aids.hallym.ac.kr/d/kns/tutor/medical/unified/somatosensory/img022.gif

Prefered stimuli get more complex as you go further up the pathway

In S1 there are cells similar to V1 simple cells that respond to the touch of oriented edges (and are tuned for orientation).

In S2 the prefered stimuli are generally more complex. e.g. There are more cells that prefer a moving edge in S2 than S1. (these cells are selective for direction of motion and probably use a circuit like we discussed for visual motion (Reichardt motion detector)))

Top Down Effects

Experience and Attention can affect perception

(response to identical input can differ under different attentional conditions or in different contexts – These are **top-down effects**)

- Placebos (with no active ingredients) can alleviate pain in some people. They are thought to release **endogenous opioids** called **endorphins**. as Naloxone blocks the effect.

- Neurons in Area S1 and S2 show attention-modulated responses. If the monkey is attending to the tactile stimulation the response is much larger than when monkey attends to an unrelated visual stimulus

Ecological Perception

Ecological view: Perception is for interaction with the environment

Most of our touch perception is **active touch** - exploring and manipulating objects. (contrast with **passive touch** which is where most experiments are done)

There are cells in monkey somatosensory cortex fire when the monkey actively grasps an object but not for passive stimulation of the skin

We are better at recognition with active touch than passive touch.

The End

Your grades will be posted on the web page (by last 5 digits of student number) Please check that we have entered everything correctly.

Lab 6 may be handed in at the final OR if you want to get it back before the final, hand it in sometime today or early friday (and specify which review session you will pick it up at) OR if you want to get it back at the final, hand it in at one of the review sessions.

Please try to come to both of the TA review sessions and the Question/Answer session with me if you are getting C's or below on your midterms.

The final is in this room 3pm Tuesday. It will be about half from after the last midterm and half cumulative comparative type questions.

Review sessions will be posted on the web page.

I very much enjoyed teaching you

Good Luck on the Final!