

Intro to Perception

CSP 502

Wednesday Bushong

- Today: all vision (it's what we understand the most of out of perceptual systems)
- Much of what we know about the structure of the visual system also applies to audition, tactile perception, haptic perception, etc.

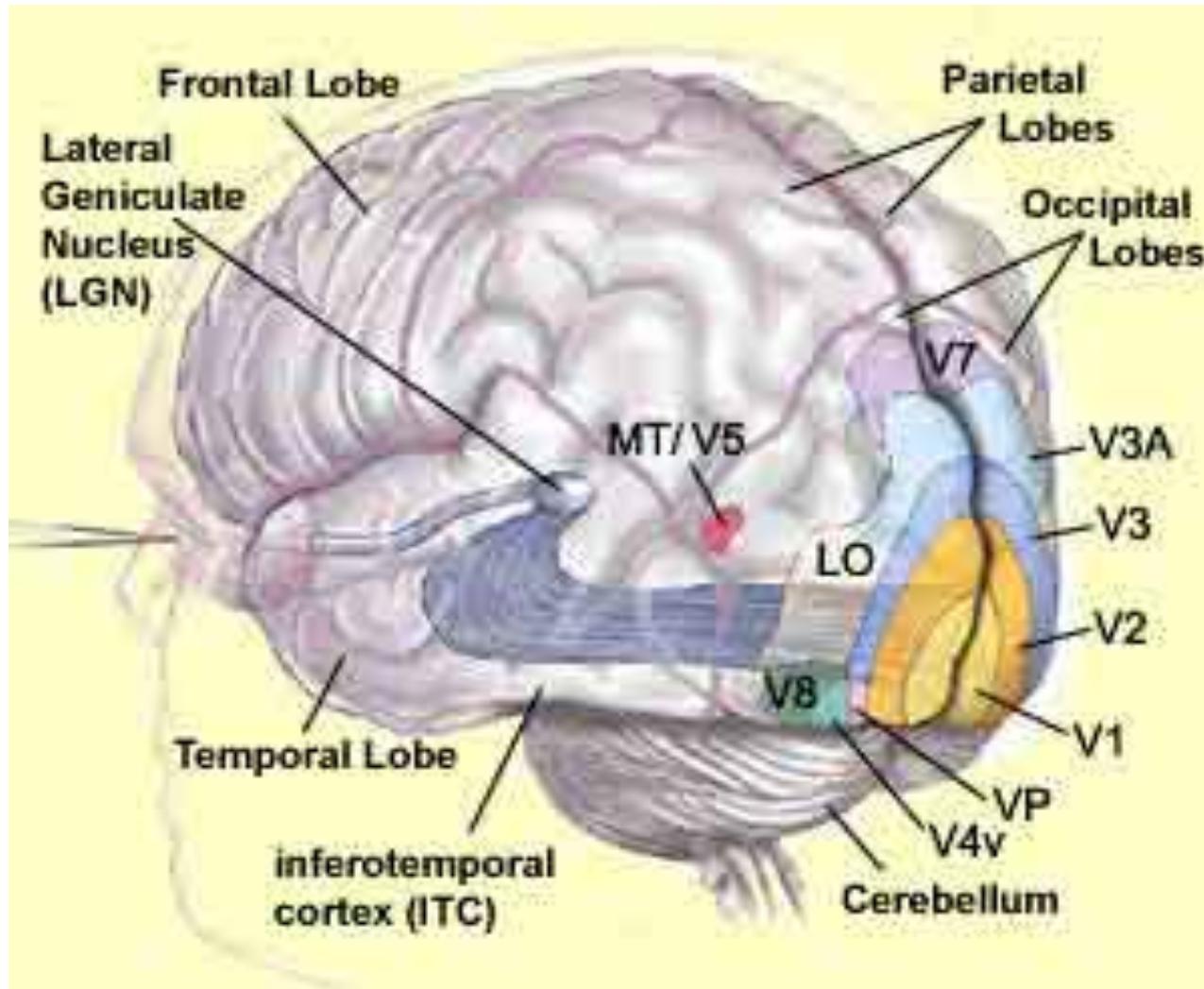
The Problem

How do we turn a bunch of photons hitting our retinas into a coherent understanding of the world?

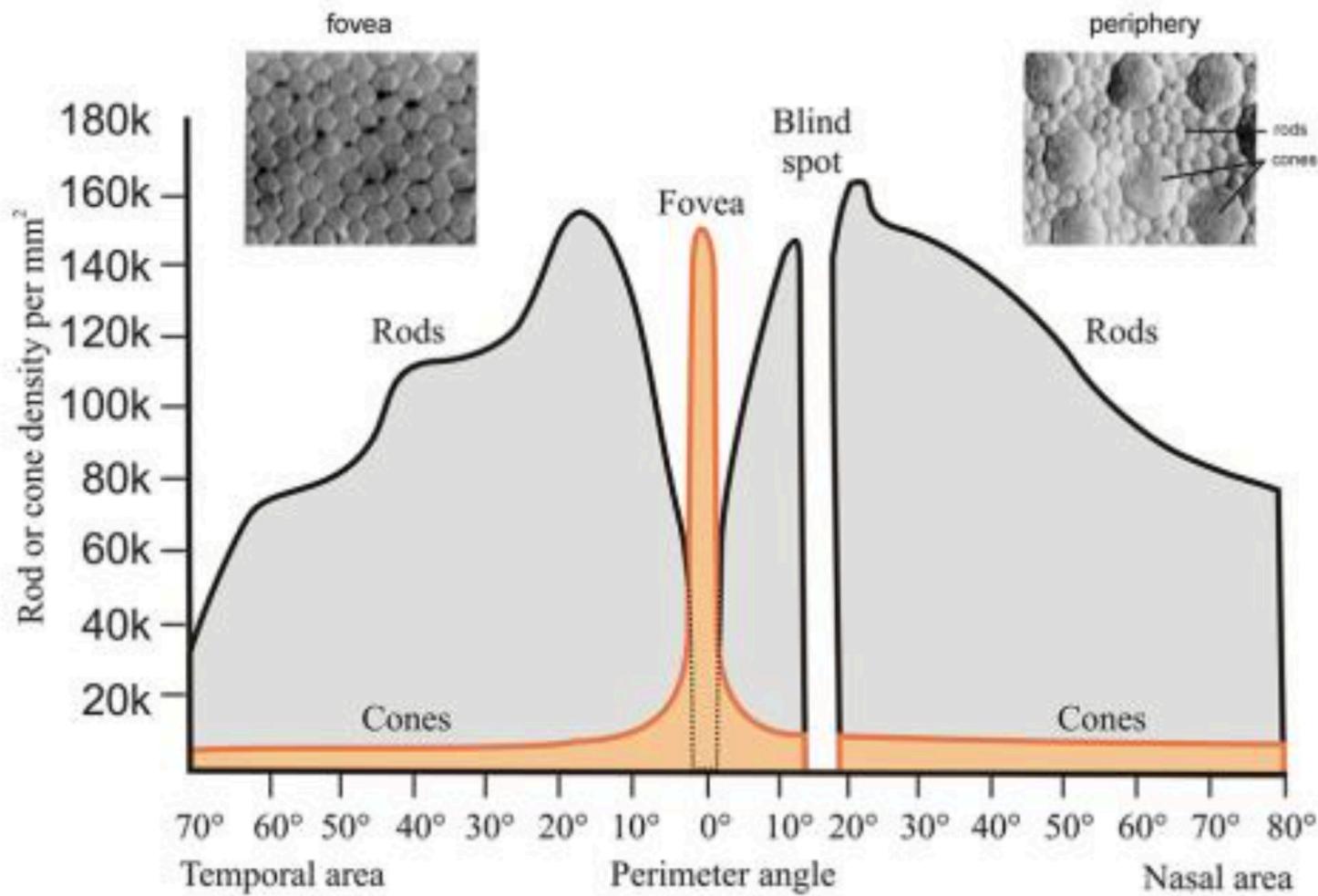
Today's topics

- 'Low-level' perception: turning retinal signals into rudimentary feature detectors in early visual areas
- Object recognition, holistic vs. part-based processing
- Perception as inference
- Perception as an active process

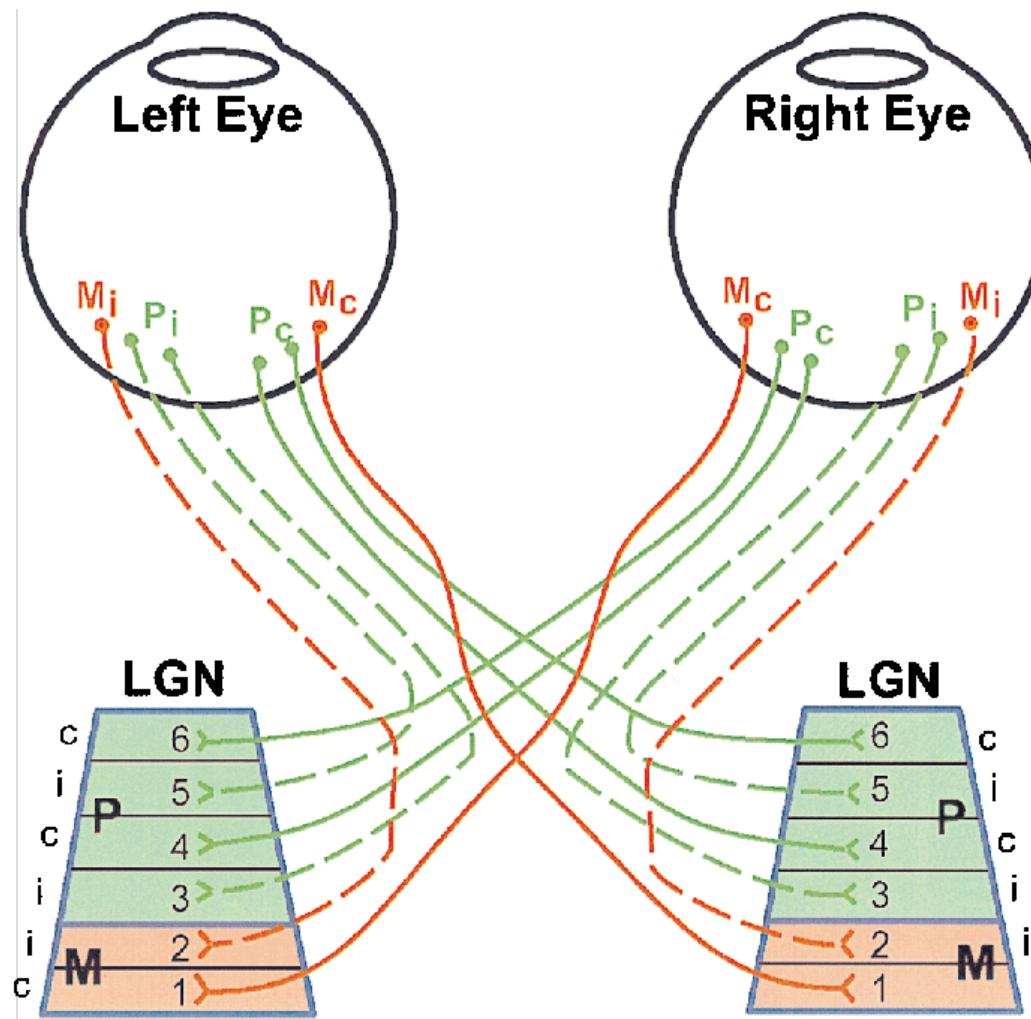
The visual system at a glance



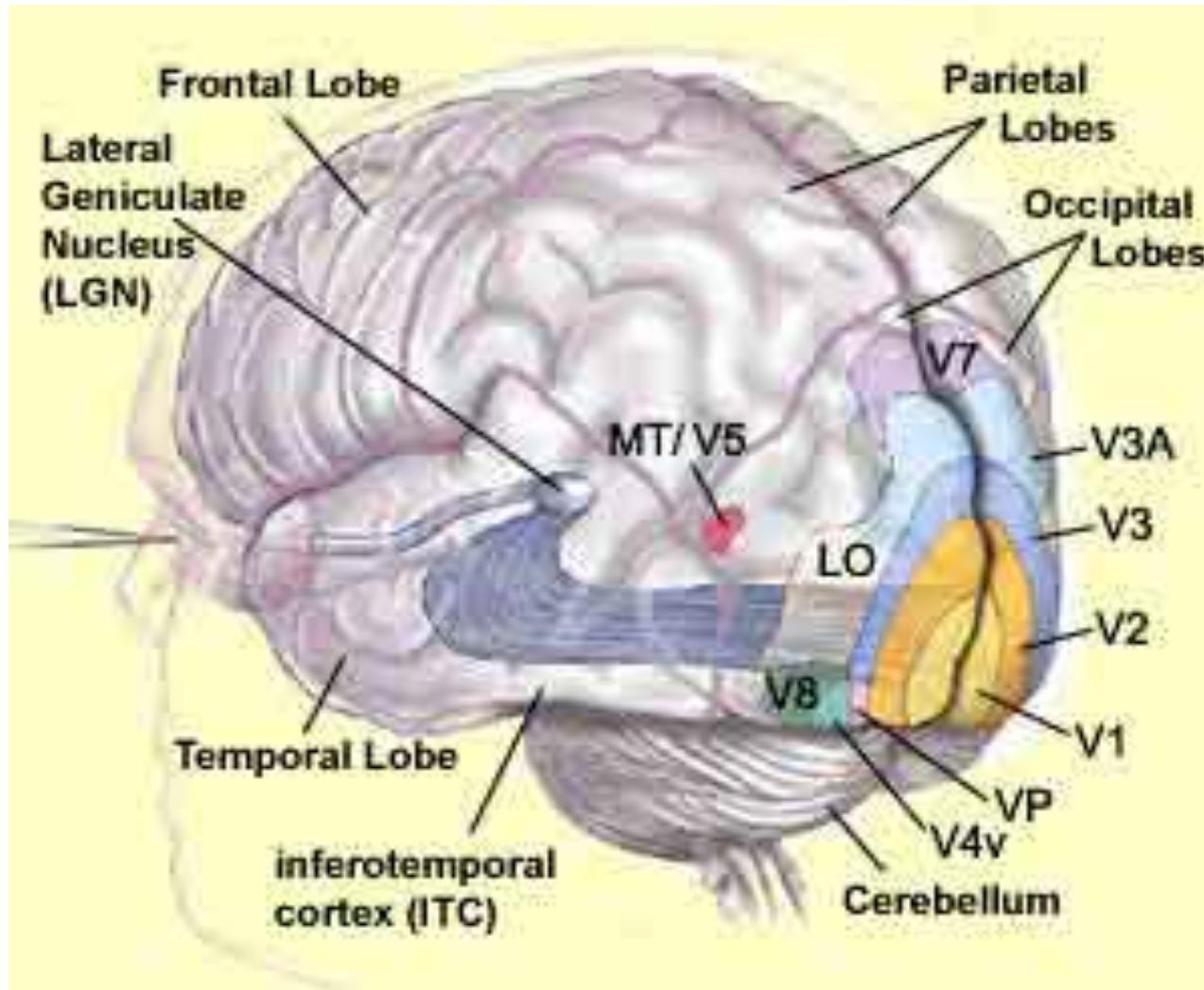
The Retina



Lateral geniculate nucleus (LGN): a waystation for sorting and passing off to the cortex

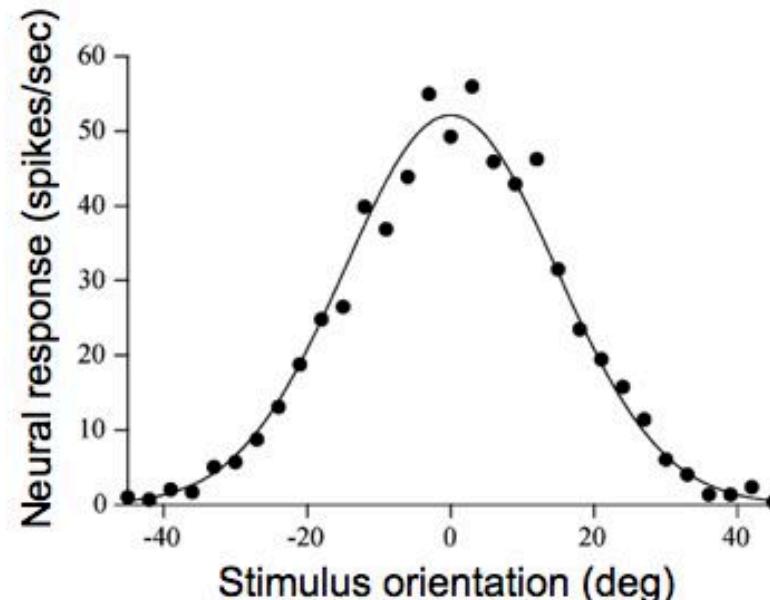
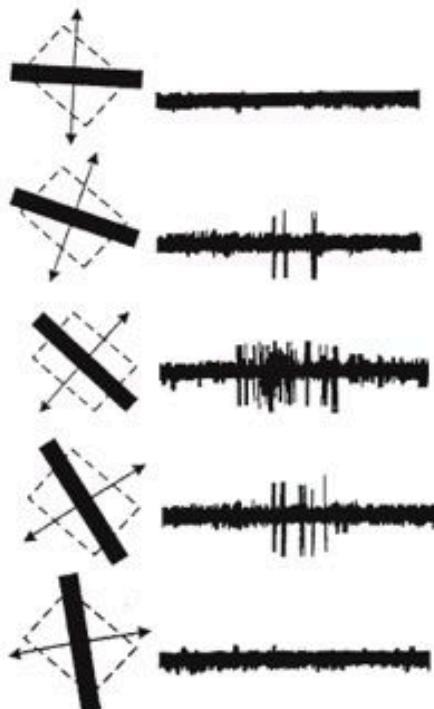


The visual system at a glance

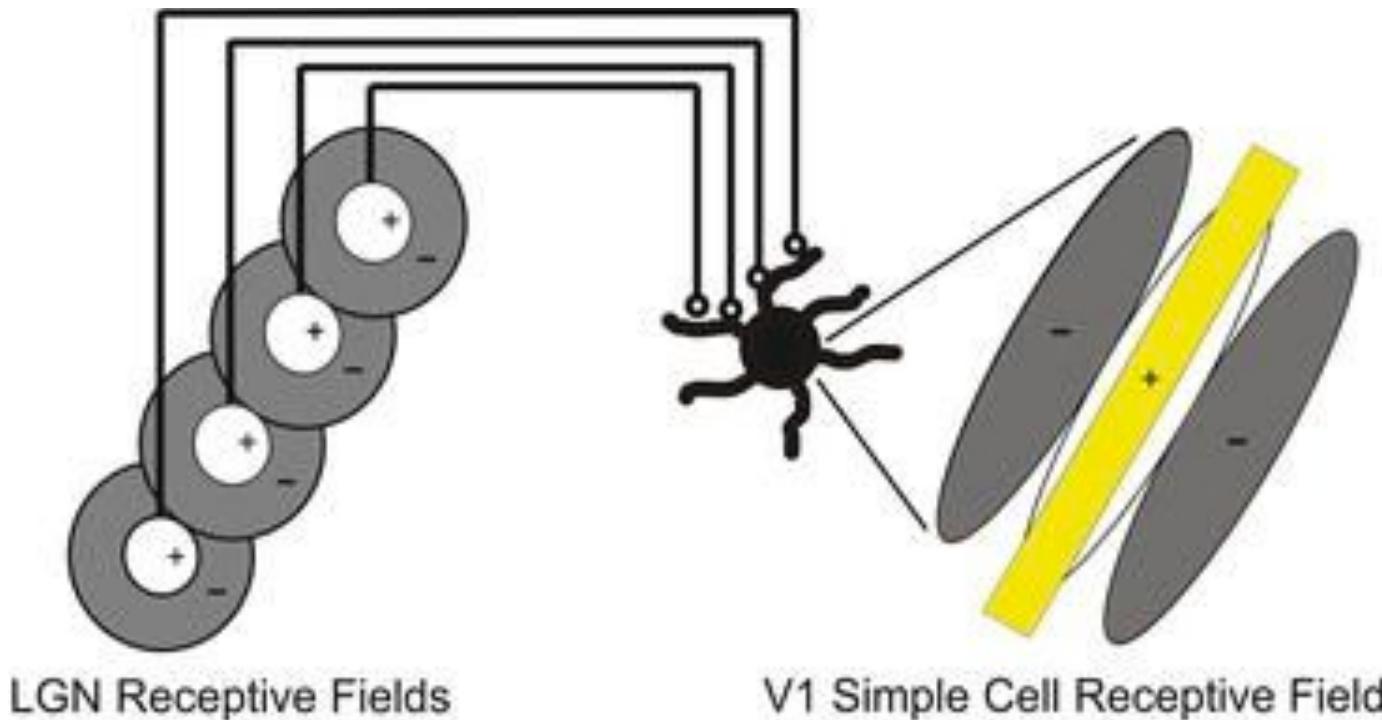


Visual neurons as feature detectors: Hubel & Wiesel's cats

[https://www.youtube.com/watch?
v=RSNofraG8ZE](https://www.youtube.com/watch?v=RSNofraG8ZE)



Receptive field of V₁ ~ = sum of
receptive fields of LGN



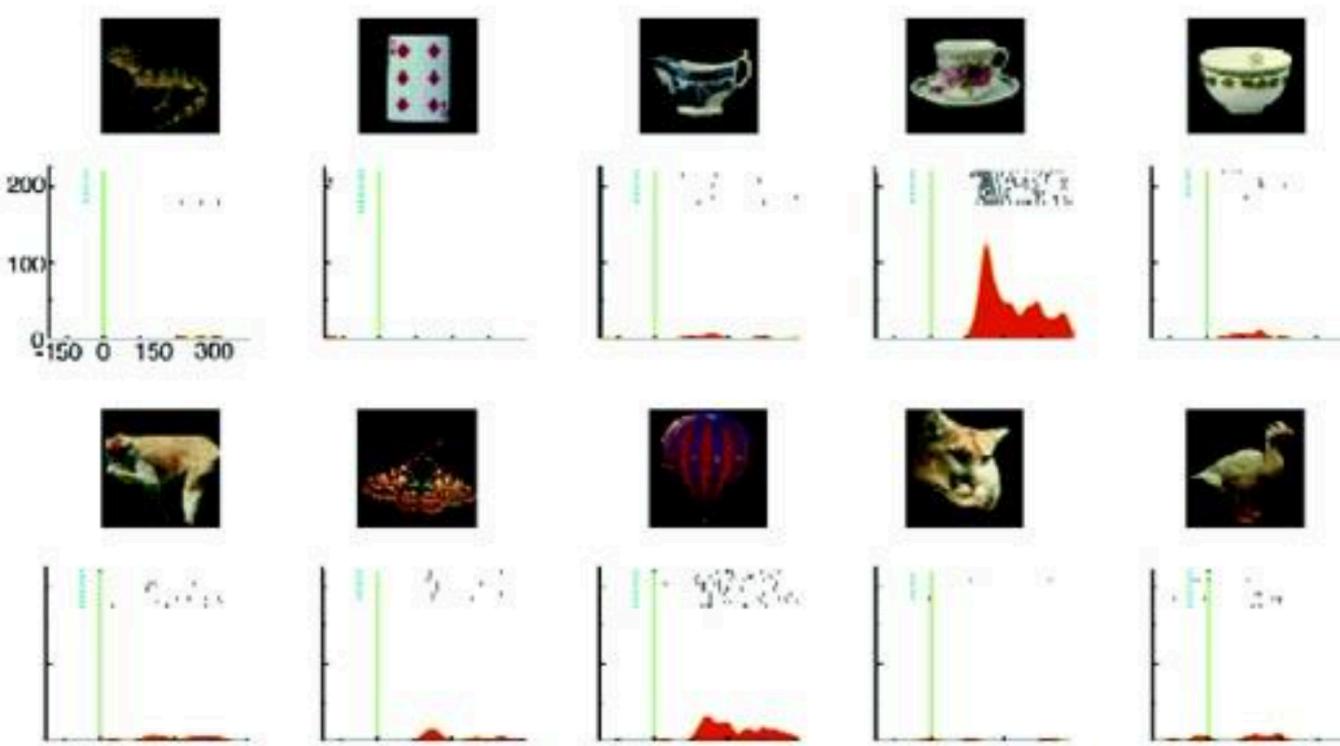
V2 receptive fields = sum of V1 receptive fields?

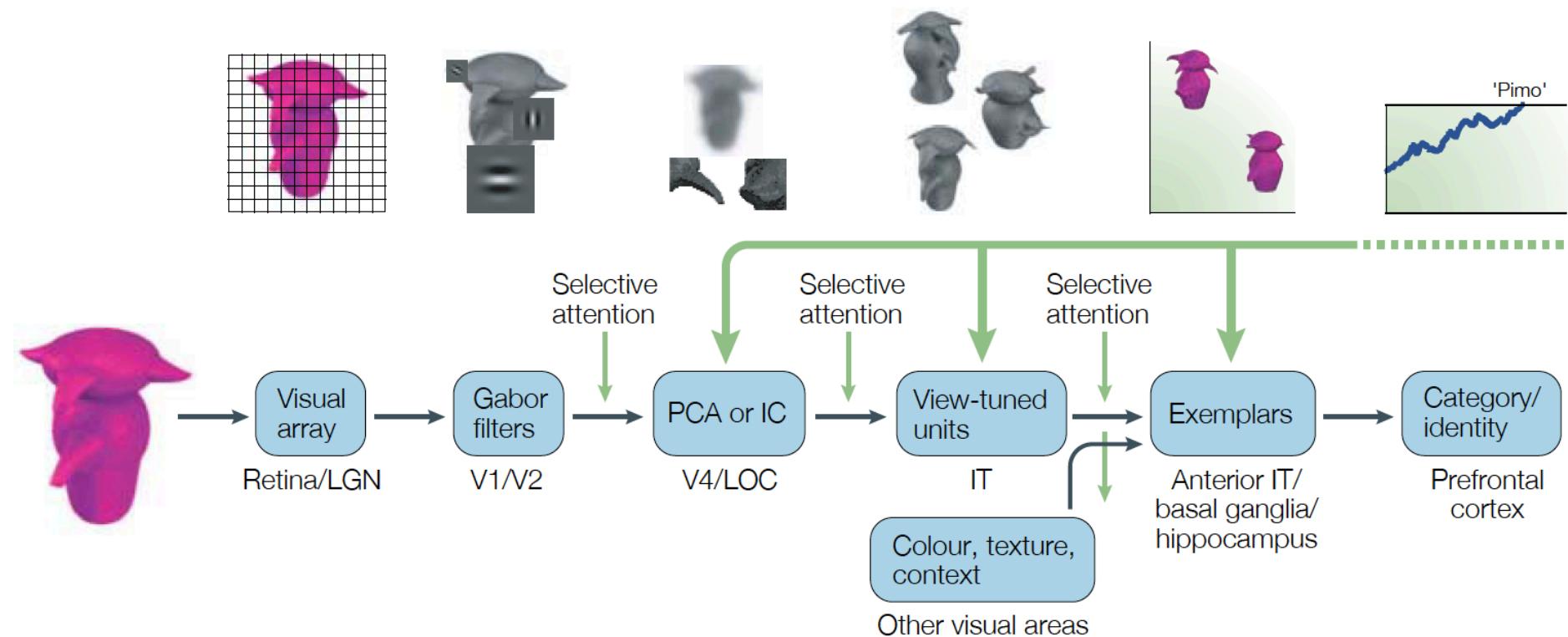
A. Cell ITC29G1



From low-level to high-level vision

- Feature selectivity gets more and more specific (and weird...)





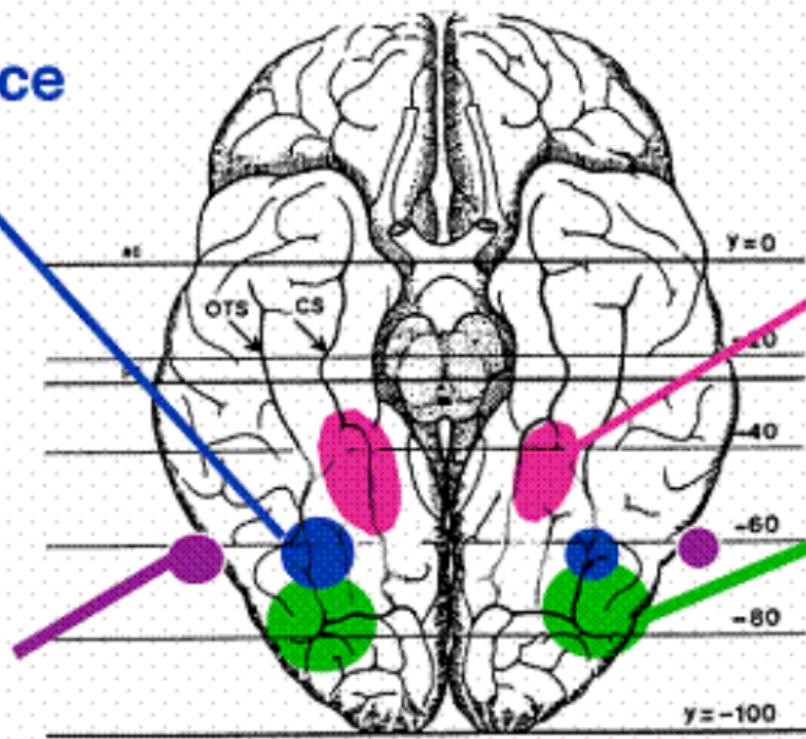
Recognition of whole objects

Fusiform Face Area (FFA)

Kanwisher et al (97-99)
Tong et al (in press)
Sergent et al (92)
Haxby et al (91, 94, 99)
Puce et al (95, 96)
McCarthy et al (97)
Halgren et al (99)

Body Area

Downing et al (01)



Parahippocampal Place Area (PPA)

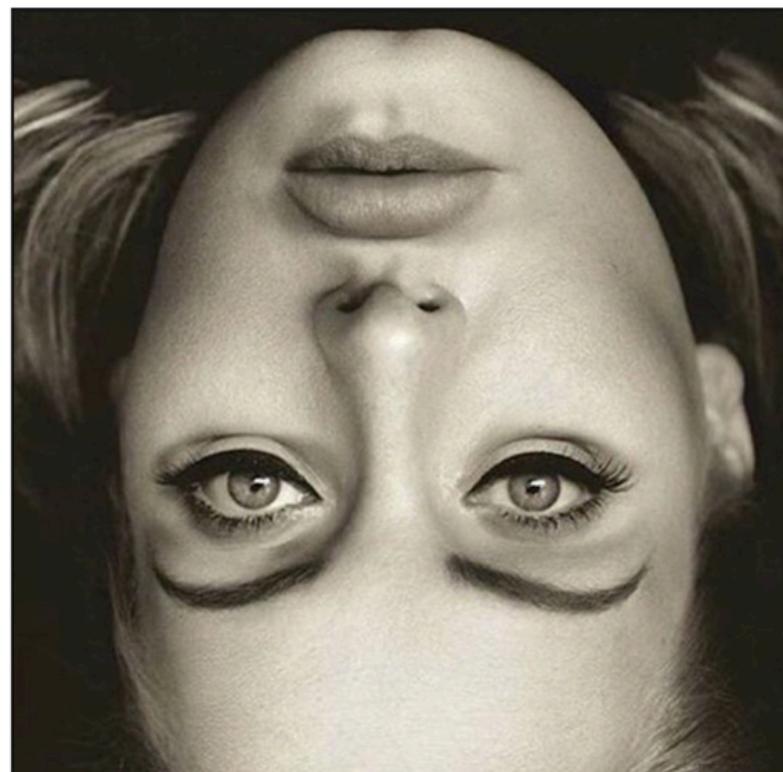
Epstein & Kanwisher (98)
Aquirre et al (98, 99)
Haxby et al (99)
Maguire et al (96, 97, 98)

LOC: Things

Malach et al. (95)
Kanwisher et al. (96)
Grill-Spector et al (98, 99)
Kourtzi & Kanwisher (00)

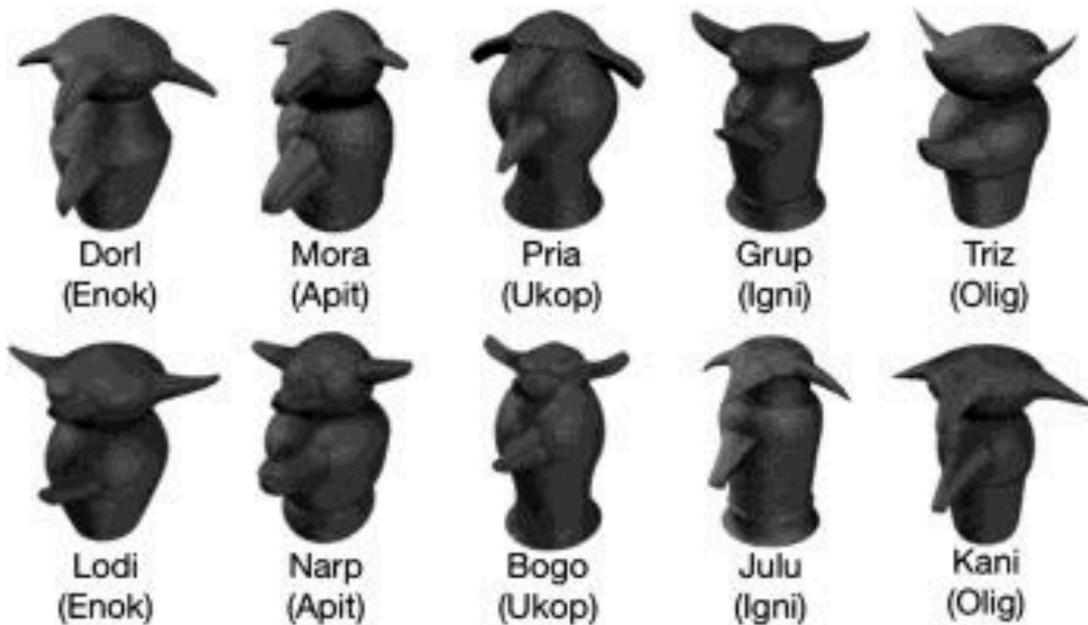


Evidence for holistic processing of faces



This kind of processing seems to arise for anything you have tons of experience with

- Cars, birds, dogs, Pokémon...
- Even novel objects with extensive training



Gauthier & Tarr (1997)

Representations of object categories abstract or concrete?

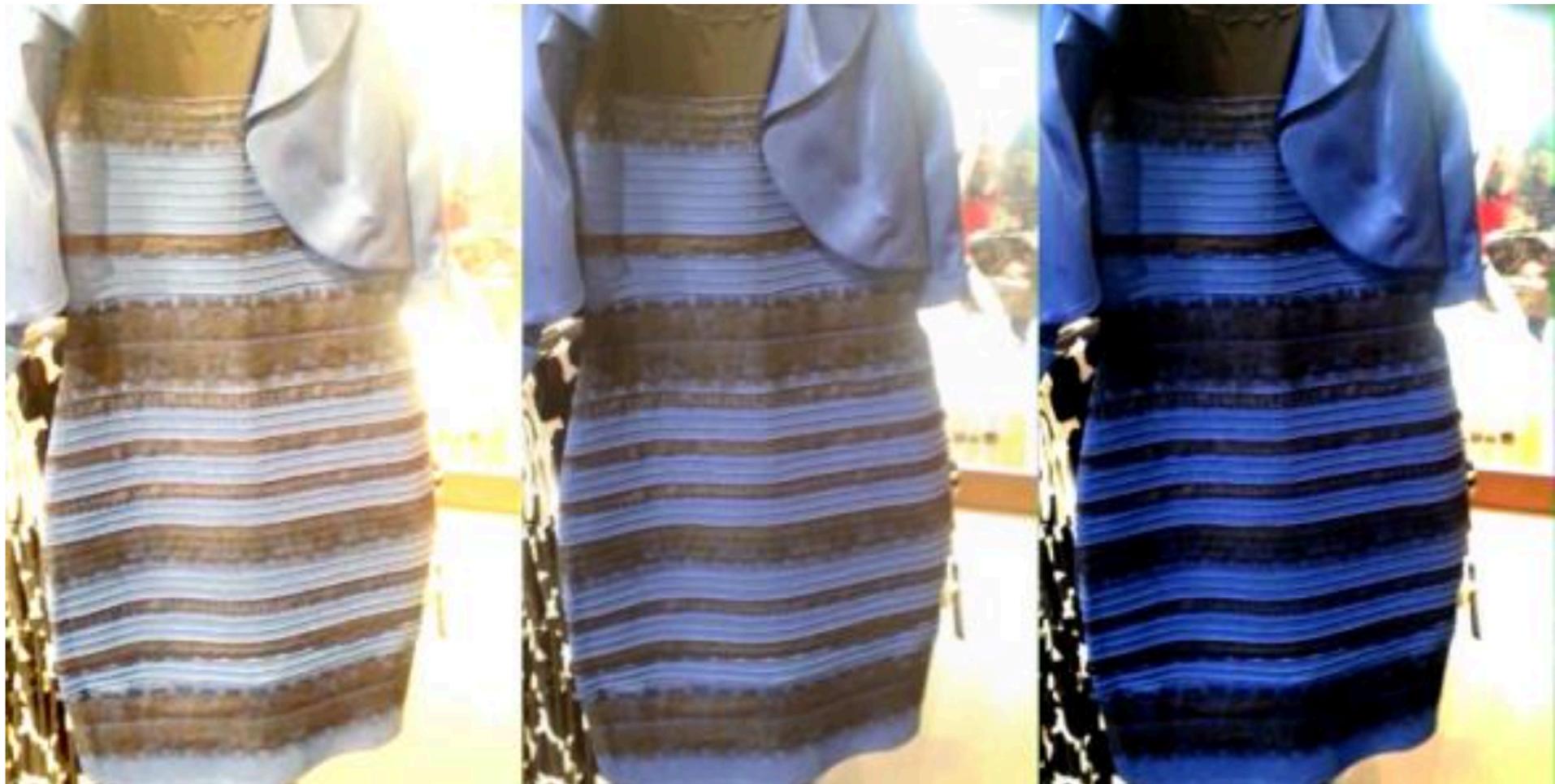
- Probably a mix of both
- In visual areas, stronger evidence for image-based/exemplar-based models
- In prefrontal areas, more abstract/categorical responses

Perception as inference

- Any visual input is consistent with many different interpretations
- How do we choose between them?
 - Combine the objective likelihood with your prior expectations (previous experience, bias, etc)



Perception of “The Dress” is linked to individuals’ general biases about illumination and color constancy (Witzel et al., 2017)



Perception as an active process



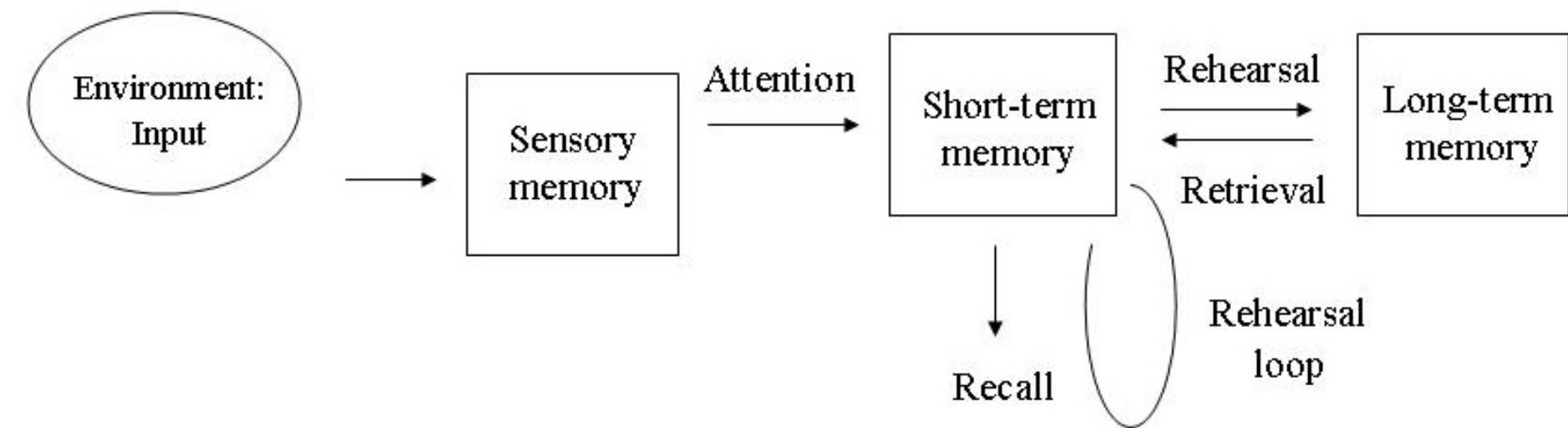
free viewing

How rich/poor is the
family?

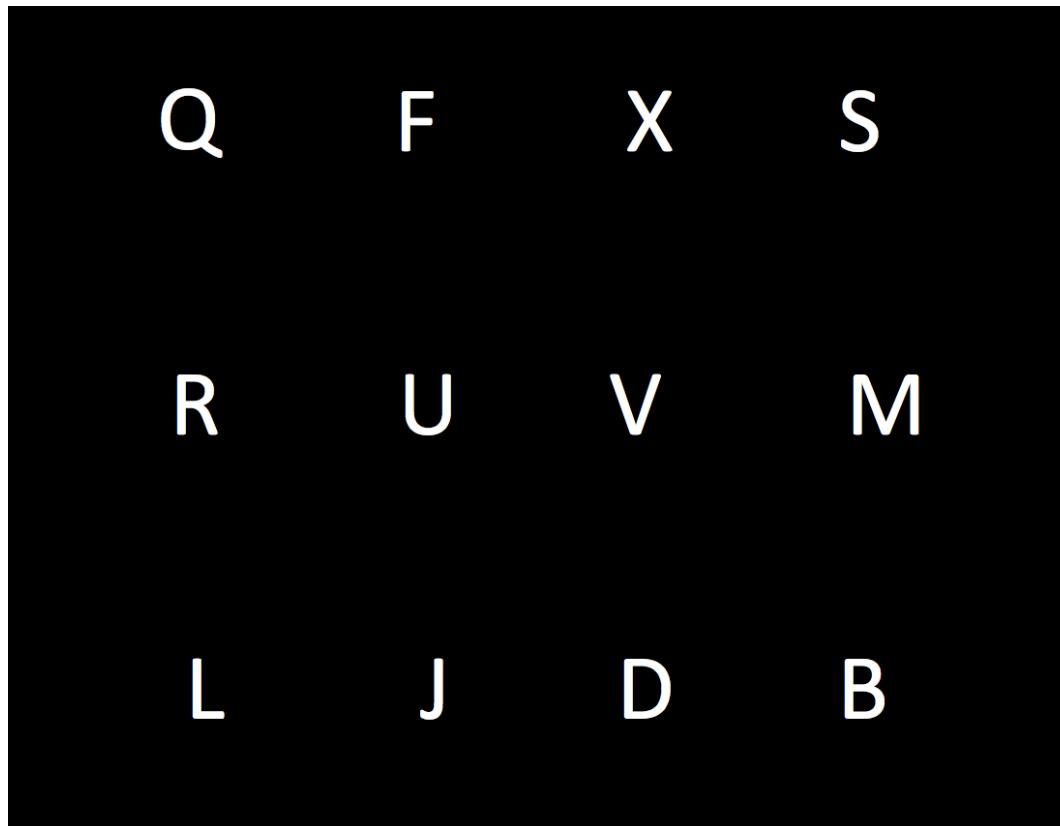
Intro to Learning & Memory

Memory timescales

- Iconic memory: very short (~hundreds of msec), extremely detailed
- Working memory: medium-length (seconds-minutes)
- Long-term memory

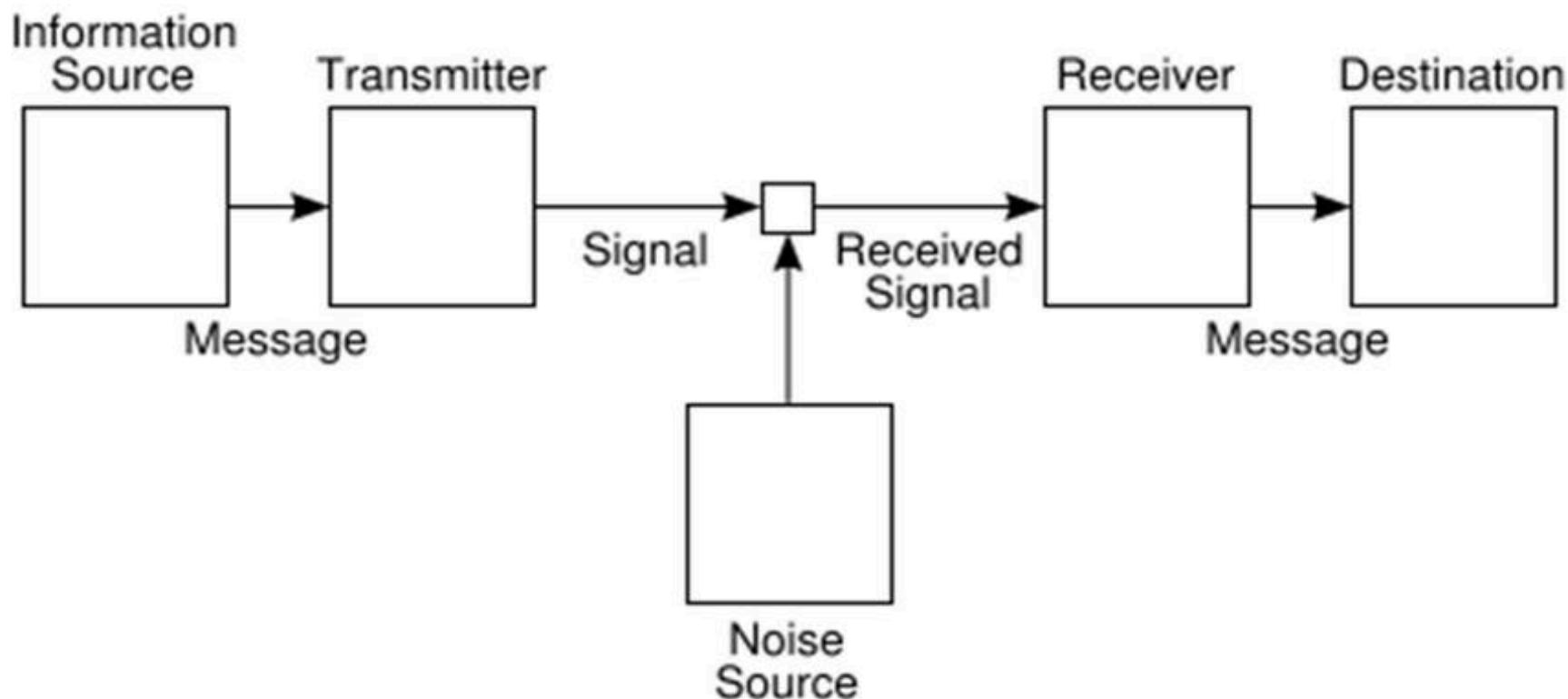


Iconic Memory

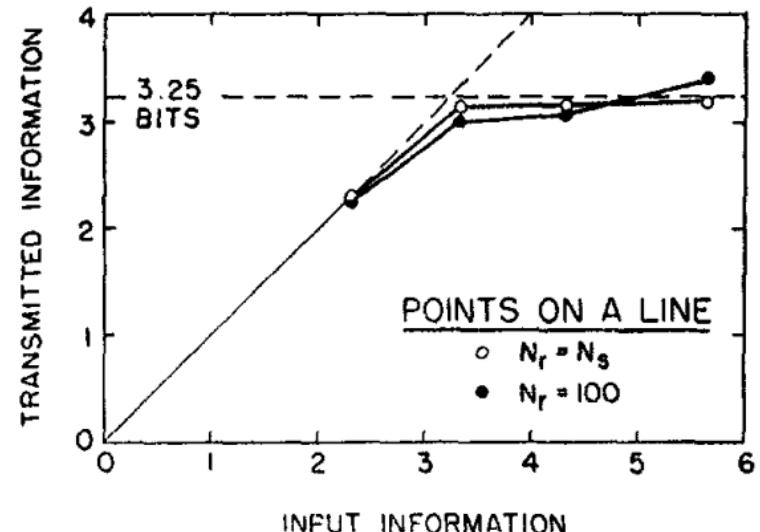
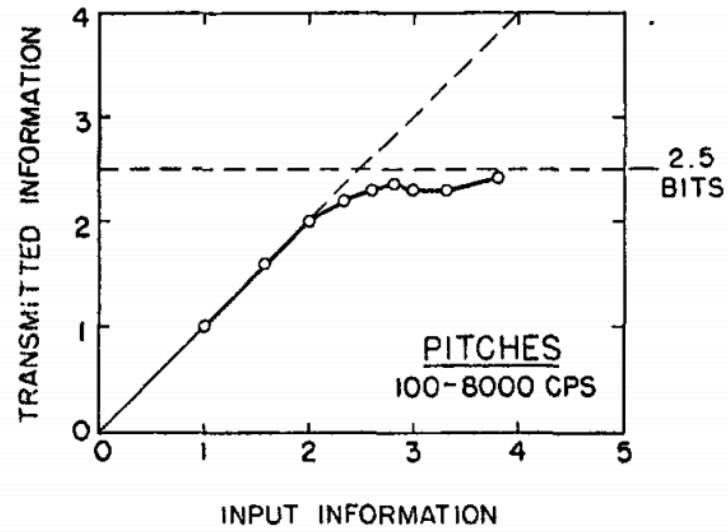


whole report vs. after-the-fact row recall – evidence that we can hold ALL of these items in iconic memory, but only for <1000ms

For slightly longer timescales, how do we encode information?



What is the channel capacity of short-term memory?



The Magic Number 7 ± 2 (Miller, 1956)
(except it's really more like 4 ± 1)

...but what about 'memory athletes'?

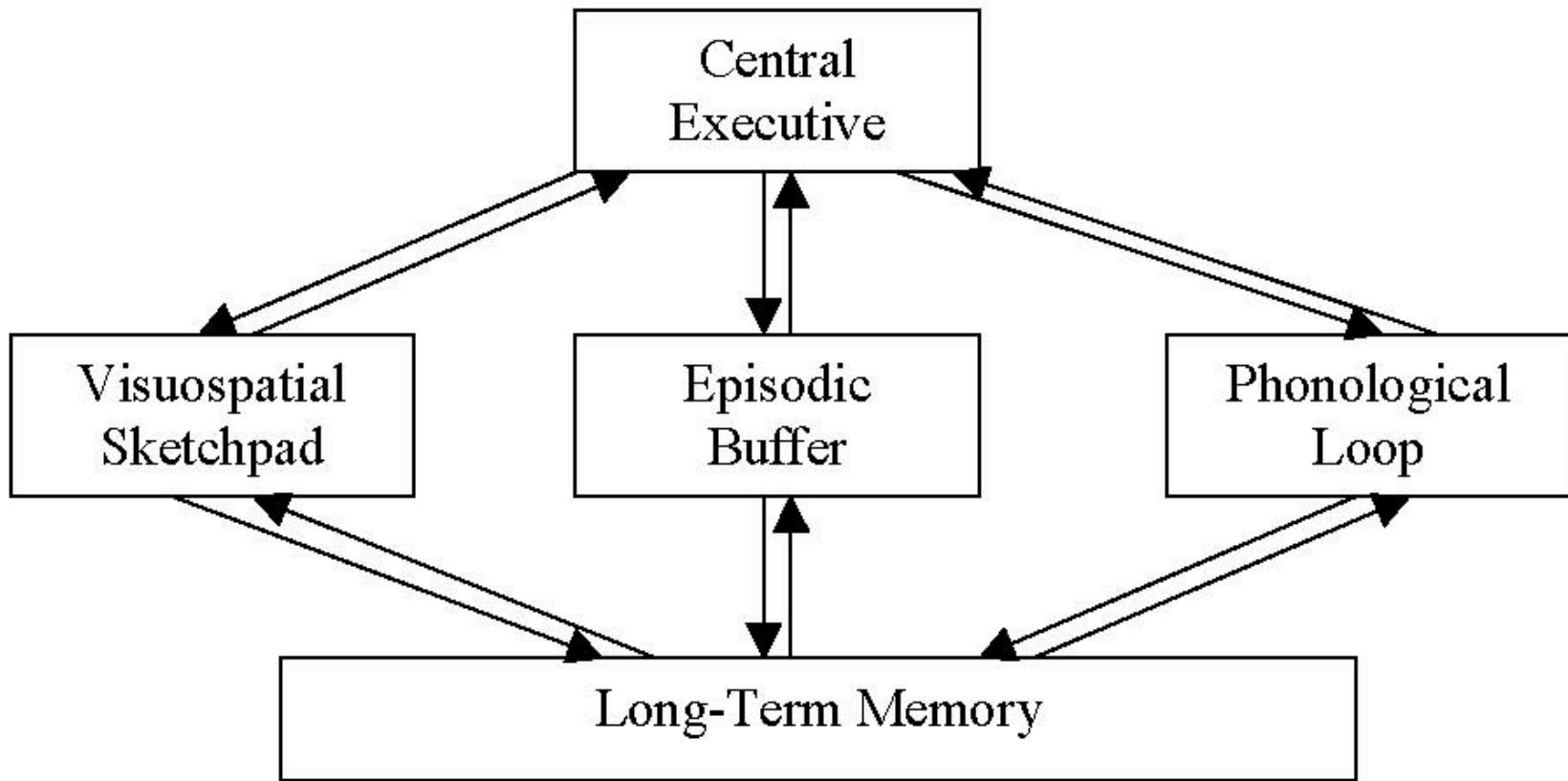
normal digit span: ~3-9

world record: 456

Chunking

- Compress sequences of stimuli into “chunks” of information you can reconstruct into the full sequence
- When accounting for this strategy, short-term memory still hovers around the magic number

Baddeley & Hitch's model of WM

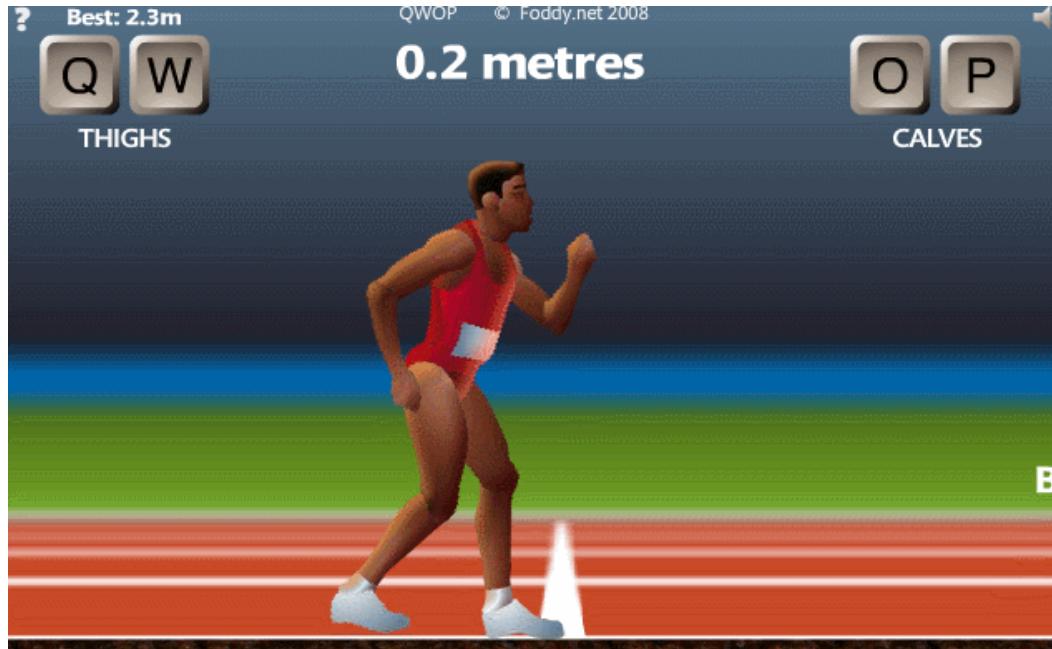


Cowan's model

- No buffers
- Everything goes to long-term memory but is 'spotlighted'
 - these long-term memories don't stick around because they become irrelevant

Types of Long-Term Memory

- Declarative
 - Episodic: Memory of specific events in your life
 - Semantic: abstract factual knowledge
- Procedural: memories that you can't verbalize



How are long-term memories encoded in the brain?

- We have no idea
 - Memories often contain highly abstract pieces of information and we barely know how any of *that* works
- One plausible idea: activation patterns re-induced by triggers