Chapter 3

Sensation and Perception

Review of Ch 2

- Neurons
- Clinical Evidence
- Neurotransmission
- Neuroanatomy
- Neuroimaging
- PDP: Neural Network Models

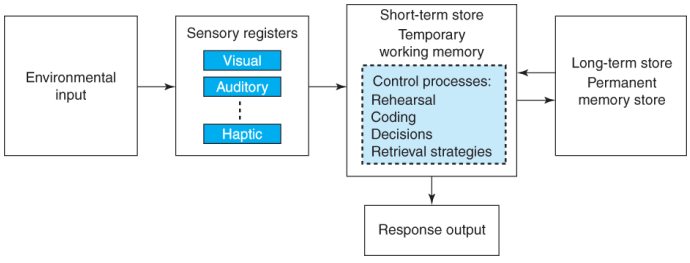
Sensation and Perception

- Visual Sensation and Perception
- Pattern Recognition
- Object Recognition and Agnosia
- Auditory Perception (skipped)

Visual Sensory Memory

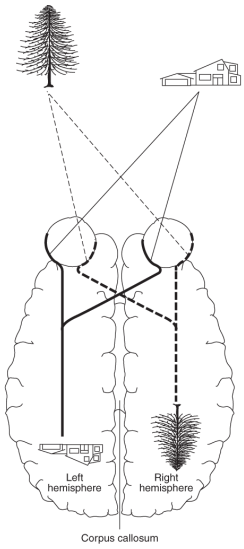
Information Processing and Cognitive Science

- Atkinson Shiffrin "Standard Model" aka "Standard Theory"

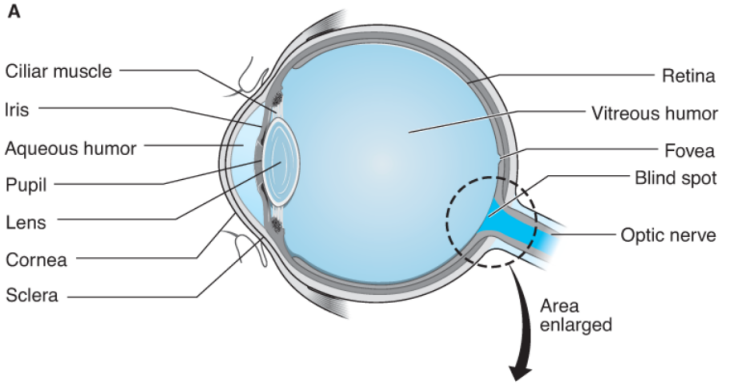


Visual Fields

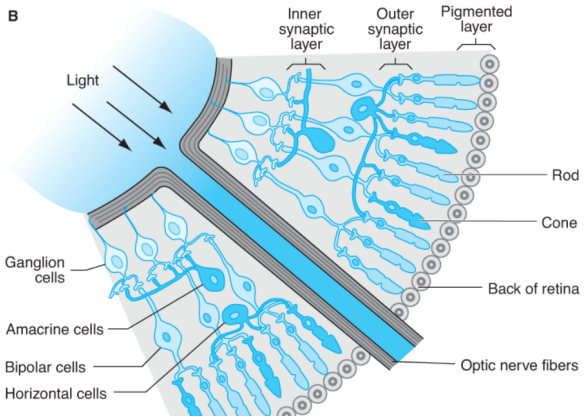
- Left visual field -> right hemisphere and vice-versa

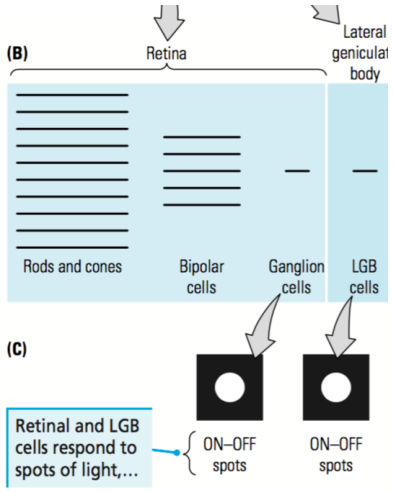


Human Visual System



Human Visual System

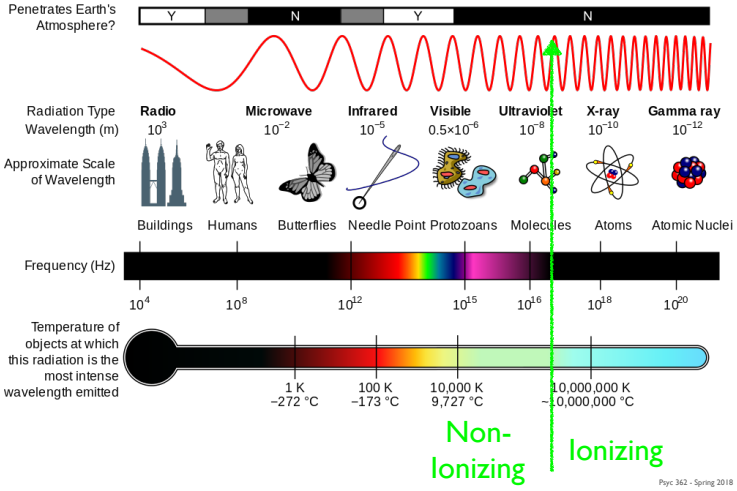




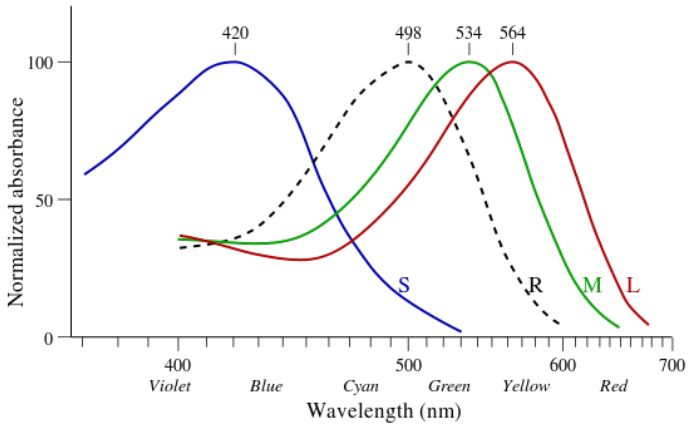
Loss of information / Simplification with levels

- Each subsequent layer has fewer neurons
- 120 million rods
- 7 million cones
  - most in fovea
  - synapse on 1 bipolar cell
- Peripheral vision:
  - 100 rods -> 1 bipolar cell

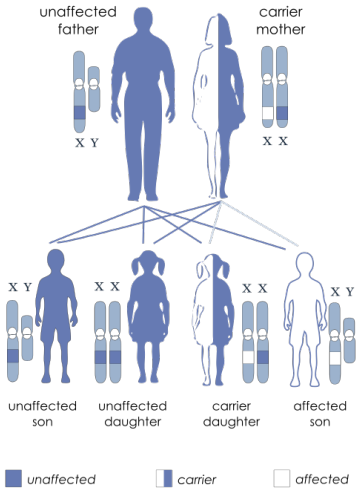
Electromagnetic Spectrum



Rods & Cones



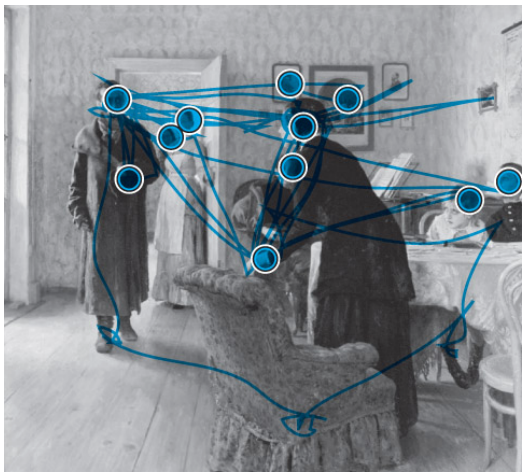
X-linked recessive inheritance



Genetics of Color Blindness

- X-linked recessive pattern

Saccades



Saccades

- Saccades (fast movements)
- Fixation (eyes still)
- About 3-4 per second
- During Saccades, visual system is suppressed
  - change blindness

Visual Sensory Memory

- Show 12 items briefly
- Normal subjects report 4-5 items
- Stimuli duration not important
  - 5msec up to 500msec

- Sperling's experiment
  - Partial Report
  - 76% correct (out of 12) = about 9 items
  - Duration is important
    - after 1 second (1000 msec) 36%

Loss of information

- Passive
  - decay, "forgetting"
- Active
  - interference
  - backward masking

Sensory Memory: Motion & Time

- After 50 msec fixation, a word can be changed without subject awareness (Rayner et al. 1981)
- Stimuli can contain motion - similar results (Finke & Freyd 1985)
  - sensory memory is not fixed snapshot
- Temporal Integration: Under 20 msec delay, items are seen as simultaneous (Loftus & Irwin 1998)

Review

- Visual System
  - Layers
    - Rods & Cones
      - wavelengths
      - colorblindness
    - Bipolar & Ganglion Cells
    - LGN/Cortex
- Perception
  - top down (blue dress example)
- Visual Sensory Memory
  - decay vs interference

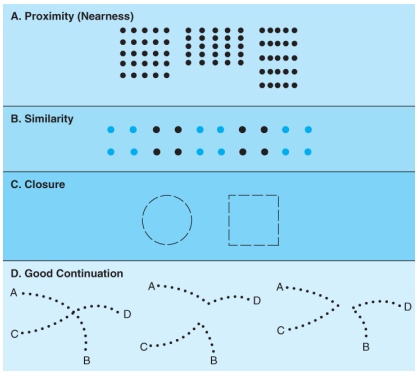
Pattern Recognition

Pattern Recognition

- A process of solving a problem:
  - understand real-world from
  - retinal sensory data

Gestalt Principles

- Proximity
- Similarity
- Closure
- Good Continuation

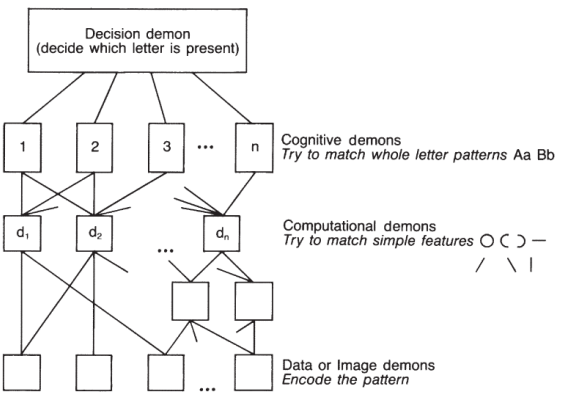


Recognition by Templates?

- Brain stores all possible variations of an object
- Impractical and probably not how the brain works.

Feature Detection

- Pandemonium model (Selfridge, 1959)



Feature Detection Models

- Layers (from low level features to high level conceptions)
- Parallel Processing
- Biological reality
  - e.g. Area 17 aka V1 in brain
- Summary: better than Template Models
- But
  - still purely Bottom-Up (Data-Driven)

Perception under Conscious Control?

- Conscious vs Unconscious influences…

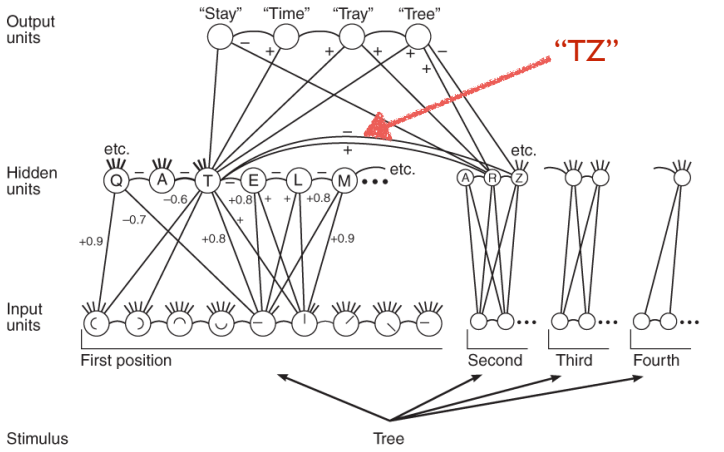
C. Search for *K*

ODUGQR
QCDUGO
CQOGRD
QUGCDR
URDGQO
GRUQDO
DUKGRO
UCGROD
DQRCGU
QDOCGU
CGUROQ
OCDURQ
UOCGQD
RGQCOU
GRUDQO
GODUCQ

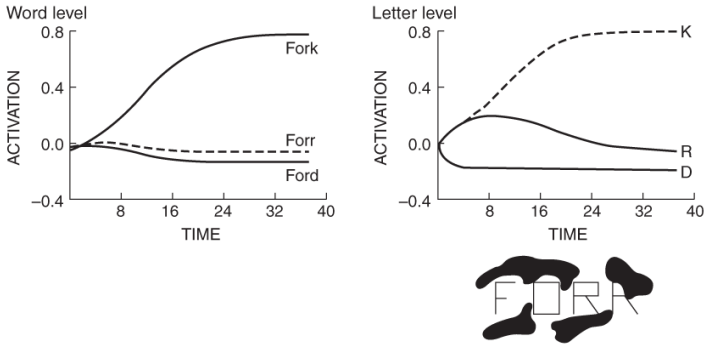
Connectionist Models

- Parallel ("massively parallel")
- Distributed
- Layers (often 3)
  - Input
  - Hidden
  - Output
- Units
  - positive, negative excitation
  - multiple inputs, one output
- Neural Network Modelling

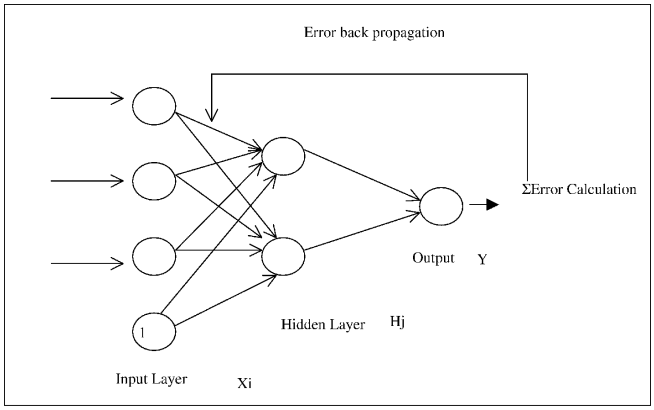
"Tree"



Mimics Biological Performance



How to train your dragon



Notes: The weight connecting node *i* in the input layer to node *j* in the hidden layer is denoted by *Wji*, and the weight connecting node *j* to the output node is represented by *Vj*

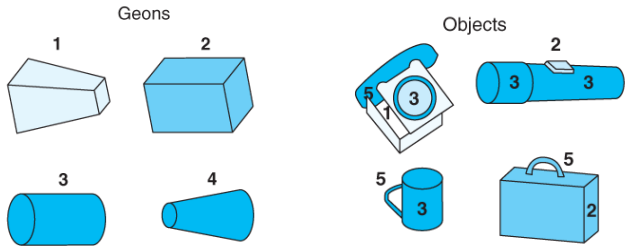
Neural Network Training

- The Delta rule
  - weights are adjusted by the amount of error
- Back Propagation
  - "Backward propagation of errors"
  - delta change changes go backwards from output layer to input layer

Object Recognition and Agnosia

Recognition by Components

- Theory: complex objects are recognized by parts
- Geons (geometric ions)
  - primitive geometrical forms



Evidence for RBC

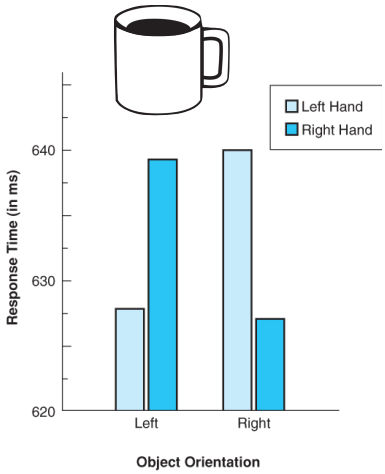
- Degraded patterns
  - where is important
- Recoverable vs. Non-Recoverable items

Evidence against RBC

- Speed: can recognize whole faster than parts
- Neuroscience: agnosia - loss of gestalt but retain RBC

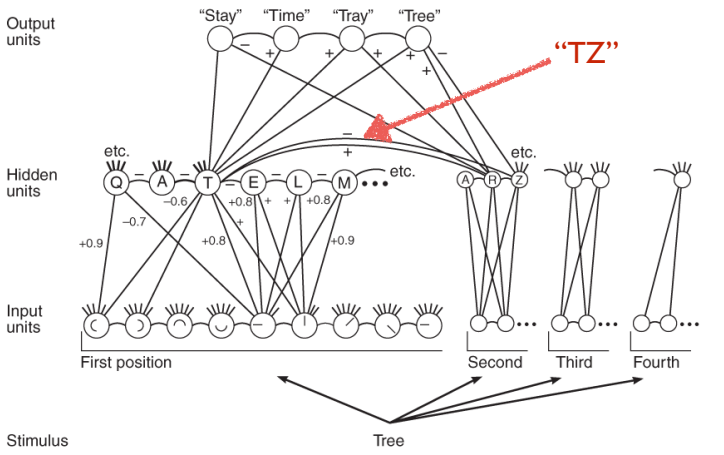
Embodied Cognition

- When looking at or thinking of object…
- Neurons in motor and sensory systems show activity, as if a person was touching or using the object.



Review

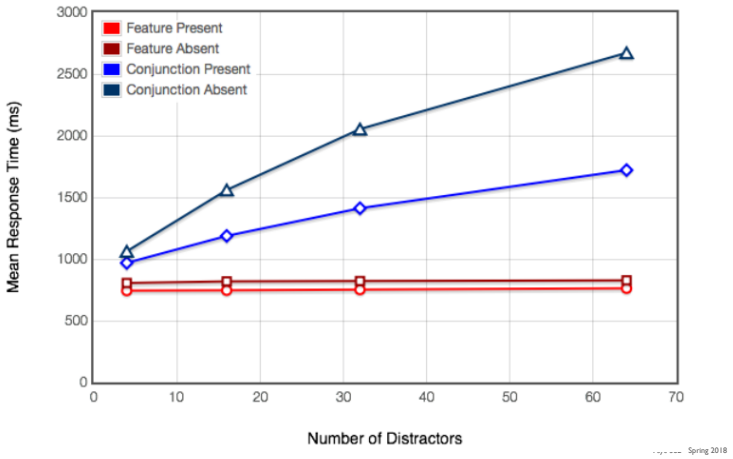
"Tree"



CogLab 3:Visual Search

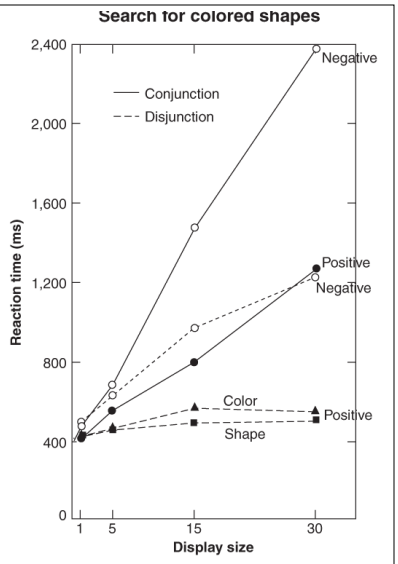
- Pattern Recognition
- Search
- Selective Attention vs. Automatic
- Feature:
  - single (green)
  - conjunction (green + circle)

Visual Search: Global Data



Visual Search

- Conjunction requires serial search:
  - exhaustive when missing
  - terminating when present
- Single feature appears to be parallel and automatic



Visual Search

- Debriefing
  - Methods?
    - feature search
    - conjunctive search
  - Predictions
    - Feature Search: RT independent of N
    - Conjunctive Search:
      - present : varies with N
      - absent: varies with 2xN (exhaustive search)
  - Robust? Limitations?

Clinical Syndrome: Agnosia

- A - lack of
- Gnosis - knowledge
- Agnosia
  - Visual Object Agnosia
    - typically Left Hemisphere Damage
  - Prosopagnosia
    - Prosopos : face
    - typically Right Hemisphere Damage

Eyes Right!

- Mrs. S in her 60s, massive stroke affecting deep/posterior right cerebral hemisphere
- Can not see items to her left
- Can not conceive of going to the left
- Goes left by making 3 right turns
- "Hemi-inattention"

The man who mistook his wife for a hat

- Dr. P, professor of music
- Inability to recognize faces
  - could recognize voice
- Couldn't tie own shoes
  - "That is my shoe?" (pointing to foot)
- Couldn't recognize object Gestalts
  - "A continuous surface, infolded on itself, five outpouchings" (Glove)
- Compensation
  - songs for life activities

Sensation & Perception : Summary

- Template model?
- Connectionist models
  - layers
  - input,hidden,output
  - many—>few
  - context effects
- Bottom up vs. Top Down?
  - Attentional Control
- Clinical Evidence
  - Agnosia