
LANGUAGE

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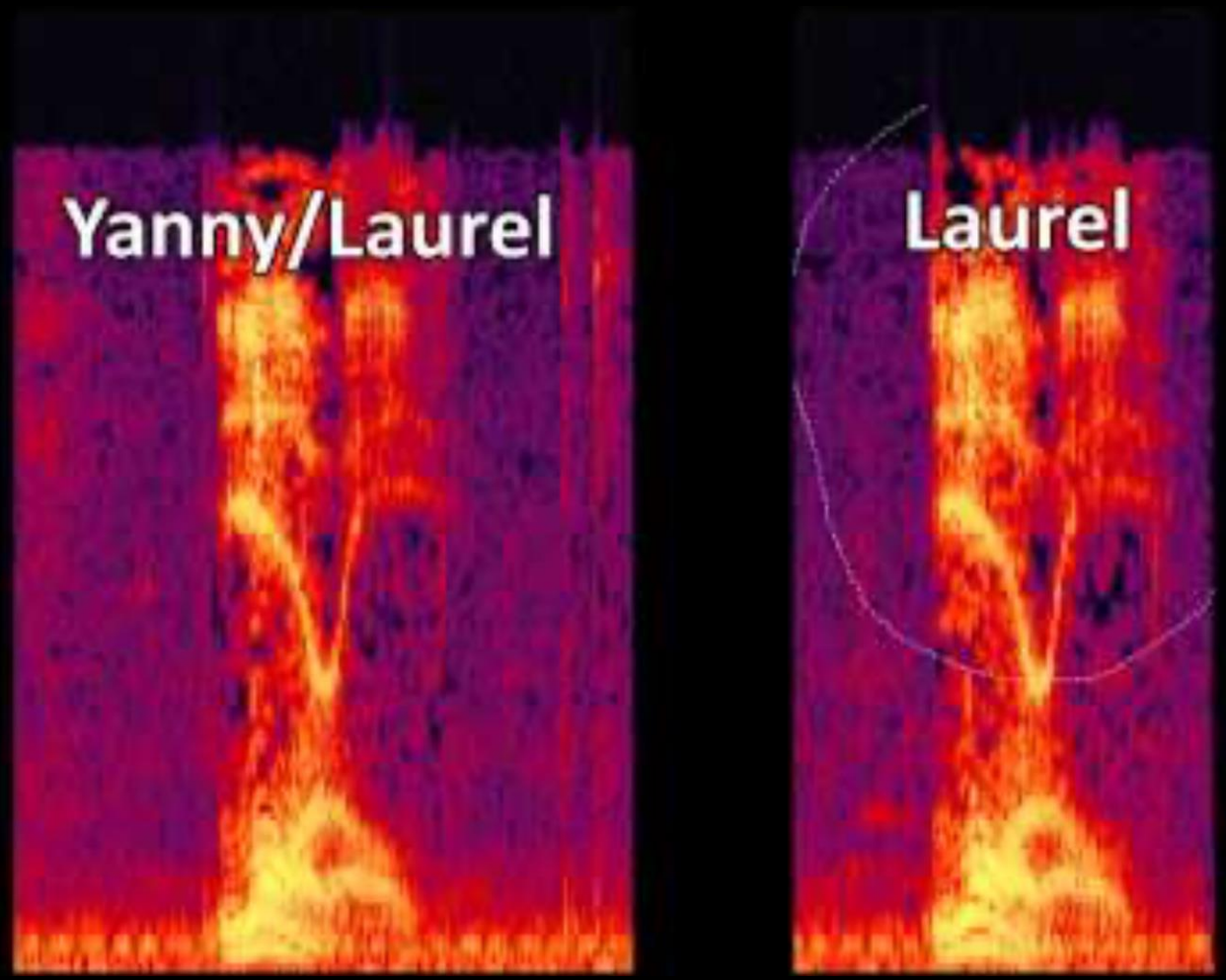

We identified several challenges for visual recognition. Which of those might also apply to auditory speech perception?

- Ambiguity
- Context
- Invariance
- All of them
- Vision and audition should have different challenges

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Ambiguity 0%

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Vision and audition should have different challenges 0%

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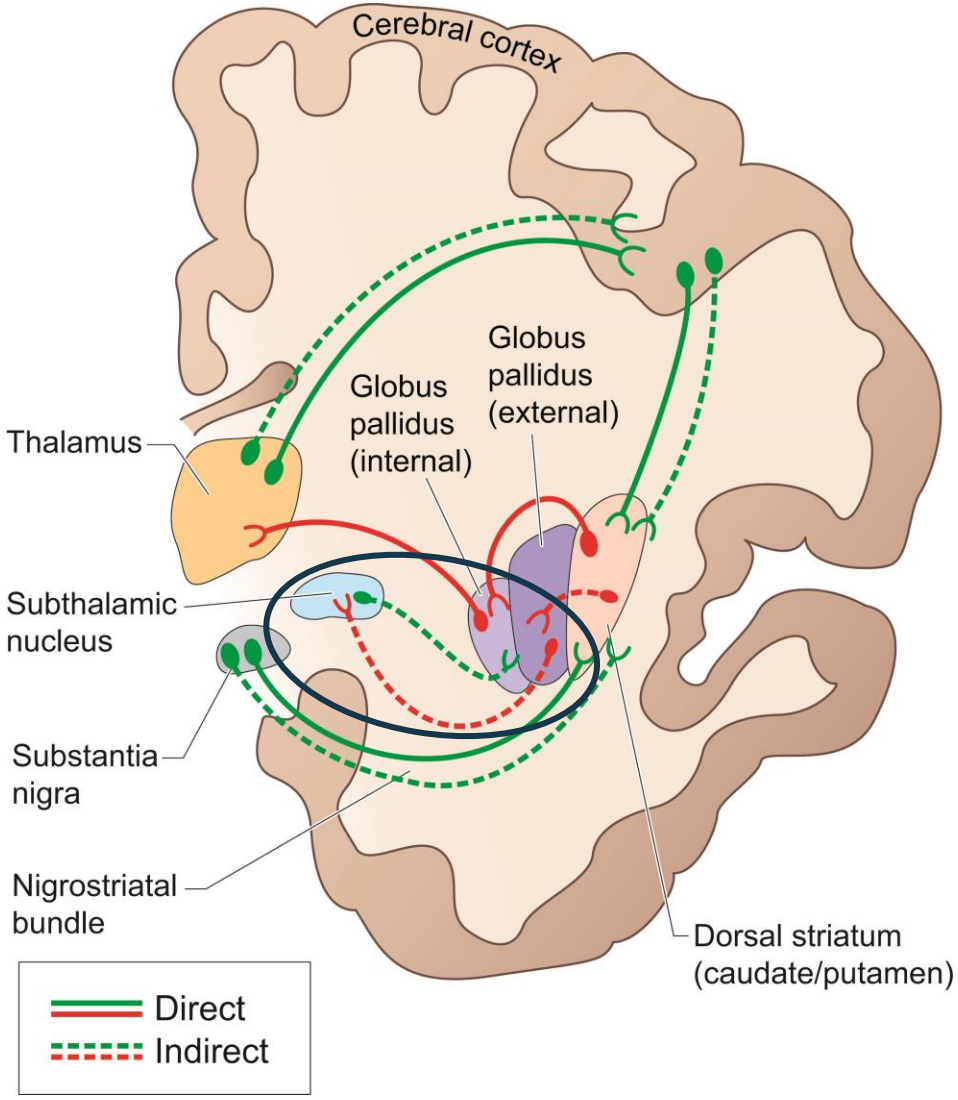
Announcements

- Study guide later this week
- Prelim 2 will cover through end of language
  - Memory will be in Prelim 3
- Neurosynth Part 2 due today

Basal Ganglia Gate Movement

- Corticostriatal loops
  - Complicated: Inhibiting inhibitor allows activation
  - Direct pathway: Excitatory for wanted movements
  - Indirect pathway: Inhibits unwanted movements
  - Usually in balance

- Nigrostriatal (dopamine):
  - Facilitate direct (D1 receptors)
  - Inhibit indirect (D2 receptors)
  - Effect is to increase activity



Two Diseases Involving the Basal Ganglia

- Parkinson's disease

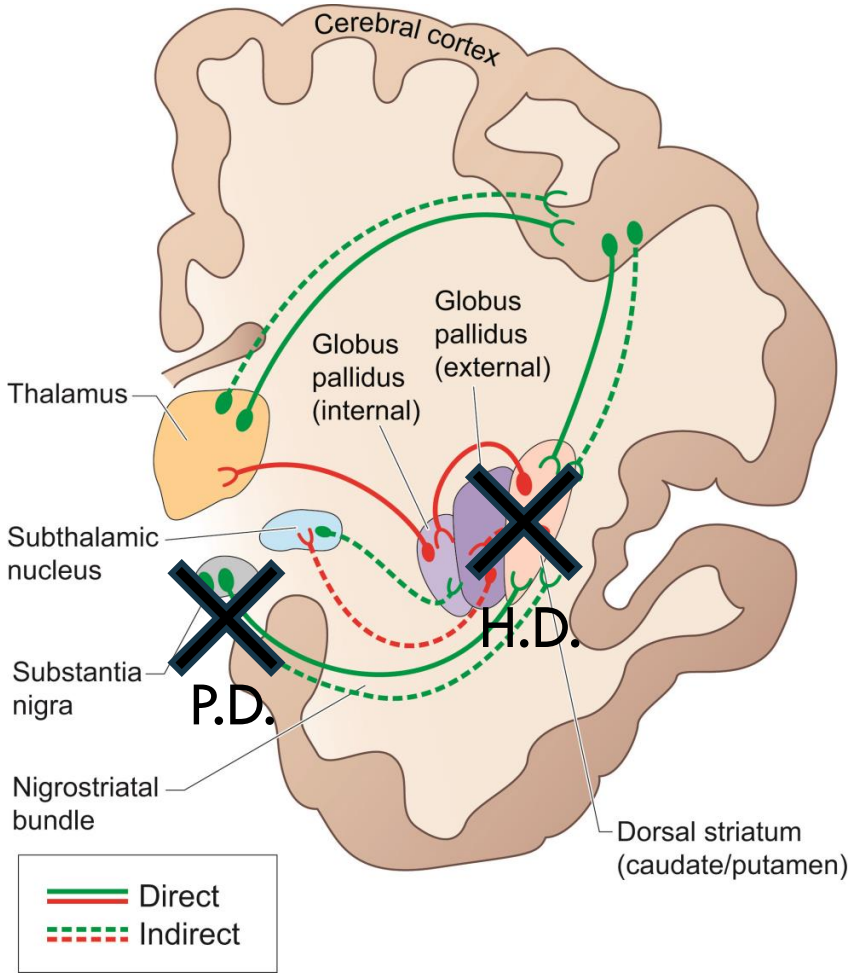
Two Diseases Involving the Basal Ganglia

- Huntington's disease

Two Diseases Involving the Basal Ganglia

- Parkinson's Disease
  - Motor symptoms: akinesia, tremor, rigidity, shuffling
  - Substantia Nigra – Dopamine loss
  - Less amplification of direct
  - Less inhibition of indirect

- Huntington's Disease
  - Motor symptoms: chorea, dystonia
  - Loss of neurons in caudate, putamen
  - Indirect pathway disrupted
  - Progresses beyond basal ganglia



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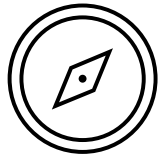
Modulating Movement



- Cerebellum
  - Several parts, several functions
  - Forward models
  - Learning

What would that movement have felt like, had it worked?

- Basal Ganglia
  - Selecting movements, actions
  - Two diseases

Start a voluntary movement, prevent an unwanted one

- Subcortical motor structures also contribute to cognition

From effectors to controllers

- Executing a movement
  - Muscles
  - Spinal cord & cranial nerves
  - Primary motor cortex
- Selecting and ordering movement
  - Basal ganglia
  - Premotor cortex
  - Supplementary motor complex
  - Cerebellum
- Evaluating a movement
  - Cerebellum
  - Parietal cortex
  - Anterior cingulate
- Integrating external info
  - Premotor cortex
  - Parietal cortex
  - Right inferior frontal cortex

What do you need to learn to learn a language?

Nobody has responded yet.

Hang tight! Responses are coming in.

What's involved in language?

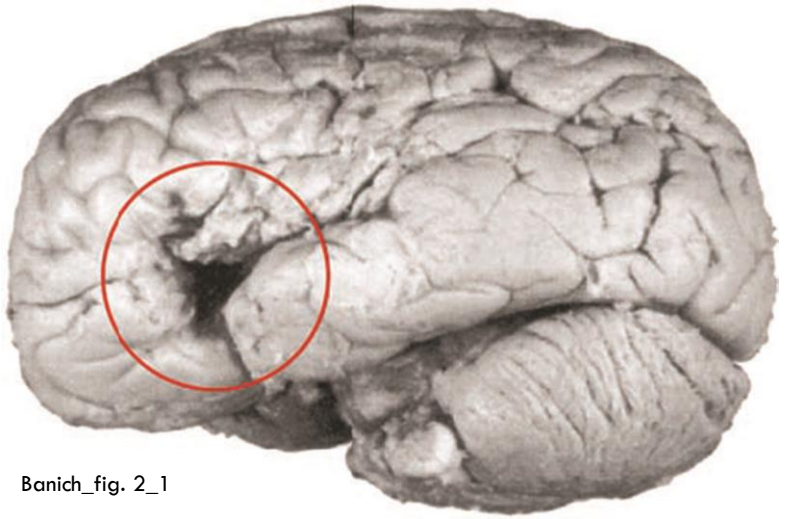
Linguistic Levels of Analysis

- Phonology
  - Rules regarding phonemes: sounds that distinguish words (e.g., rat, bat, fat)
- Morphology
  - Rules regarding morphemes: smallest units of words that carry meaning (e.g., go, -ing, -es)
- Syntax
  - Rules that govern how words are combined
- Semantics
  - Meaning of utterances
- Pragmatics
  - Contributions from context

Language is productive

Production vs Comprehension

- Broca's aphasia
  - Language production disrupted
  - "Non-fluent"/expressive aphasia
  - Damage to left inferior frontal cortex (BA 44/45)



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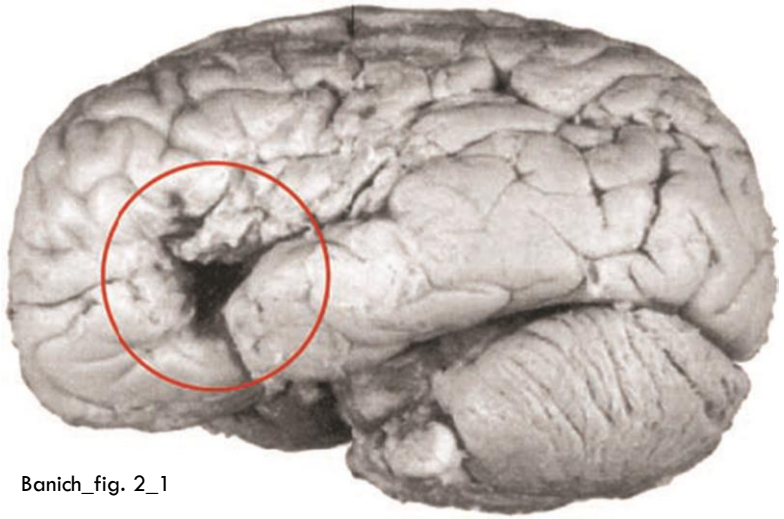
- <u>Telegraphic speech</u>
  - Missing function words
  - Agrammatical

- Also, limited writing, signing in ASL

Production vs Comprehension



Banich_fig. 2_1

- Broca's aphasia
  - Language production disrupted
  - "Non-fluent"/expressive aphasia
  - Damage to left inferior frontal cortex (BA 44/45)

- Difficulty understanding more unusual sentence structures
  - Active vs. passive

    The dog bit the boy.

    The boy was bit by the dog.

  - Garden path

    Mary gave the child the dog bit a bandaid.

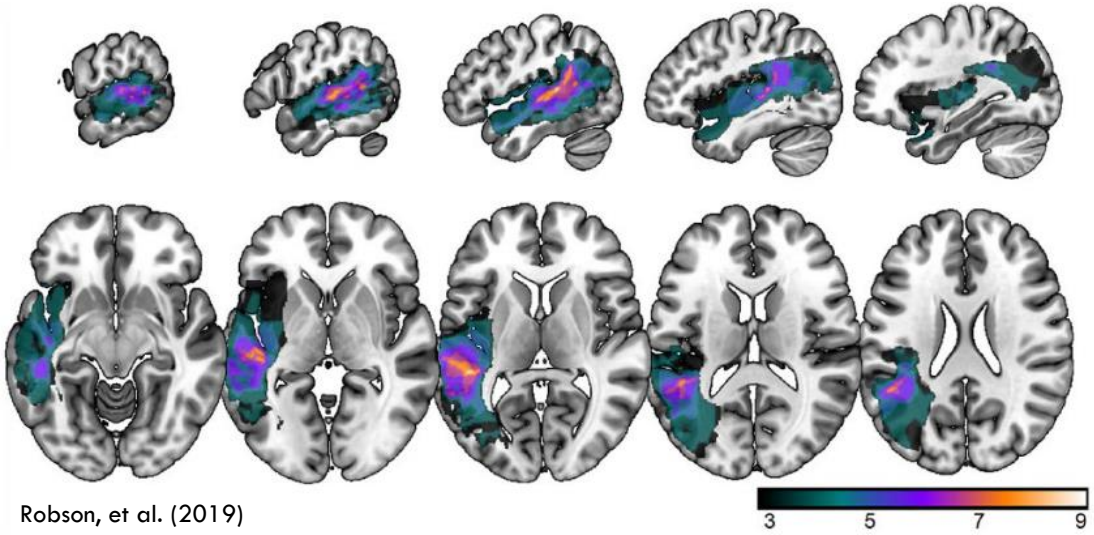
    The old man the boat.

    Since Jay always jogs a mile seems like a very short distance to him.

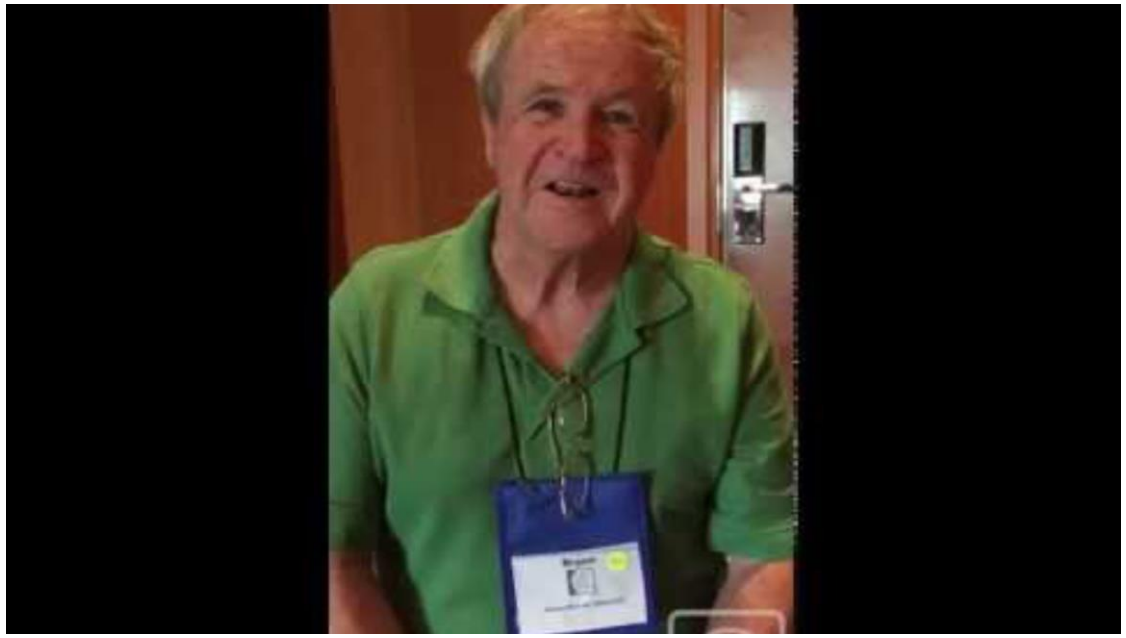
Production vs Comprehension

- Wernicke's aphasia
  - Language comprehension disrupted
  - "Fluent"/Receptive Aphasia
  - Damage to left posterior superior temporal gyrus (~BA 39)

- Word salad
- Syntax is pretty good



Robson, et al. (2019)



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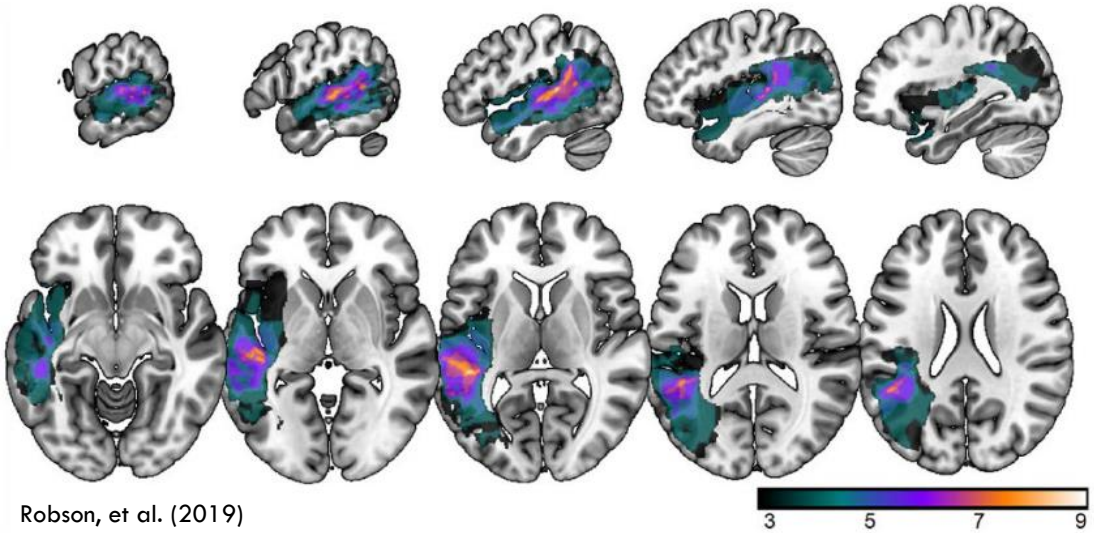


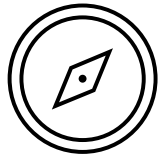
Robson, et al. (2019)

- Paraphasias
  - Semantic — e.g., The lumberjack used a hammer to chop down the tree
  - Phonemic — e.g., "cime" rather than "crime"; "renoversh" rather than "renovations"
  - Neologisms — e.g., "hetly"; "blorsh"; phonologically fine, but unlike neologisms connected to meaning

Production vs Comprehension

- Distinguish between production and comprehension?
- Do different brain regions carry out different linguistic levels of analysis?
- Anterior/posterior distinction? Or dorsal/ventral?
- Lesions suggest it's complicated
- Let's dig in…

The plan

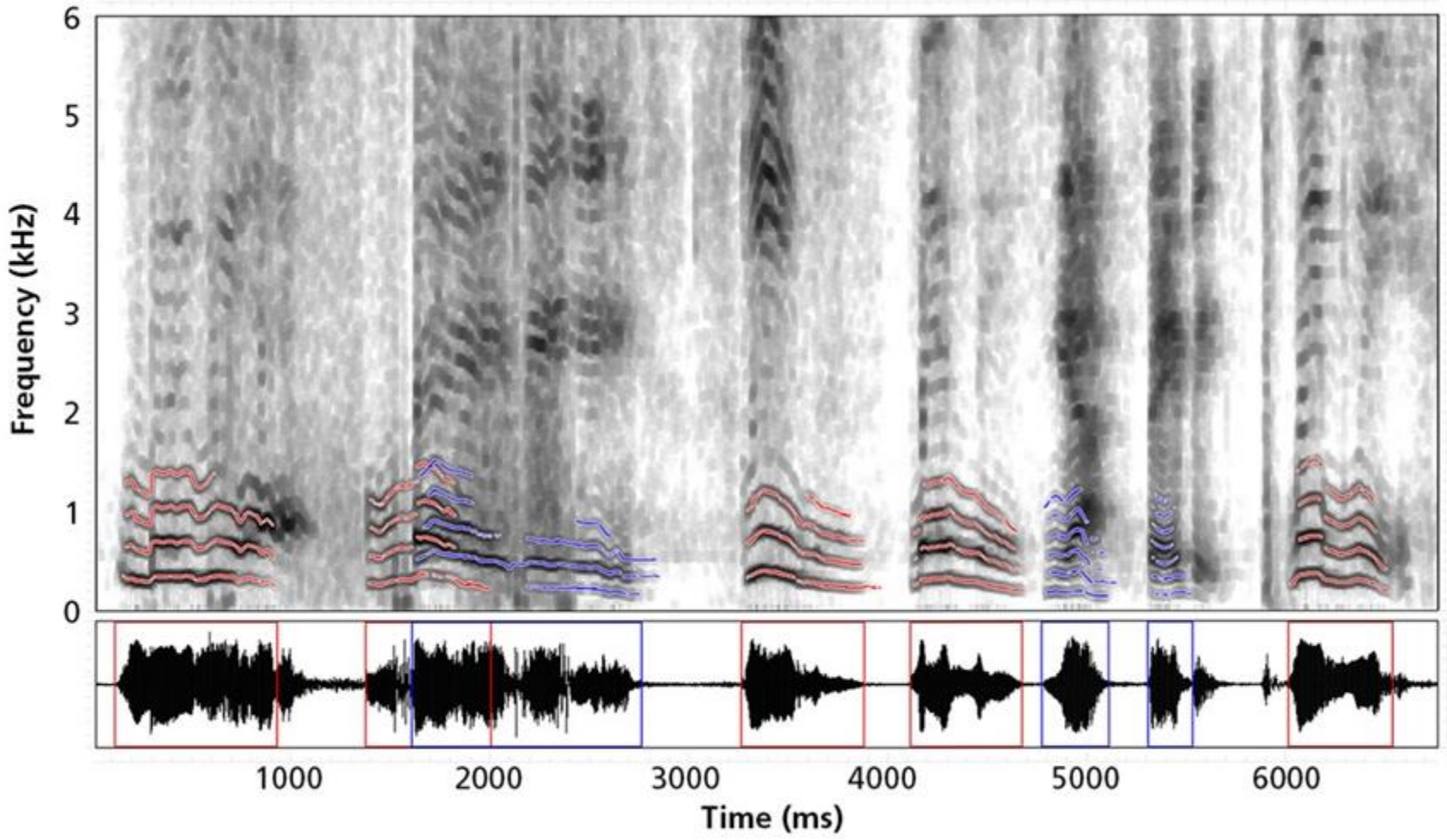


- Overall: How are sounds linked to meaning?
- What are the phonemes? Words?
  - Auditory processing
  - Visual & motor integration
  - Statistical learning
- Hierarchical structures and prediction
- How is meaning represented in the brain?

From Sounds to Words

Visualizing Sound

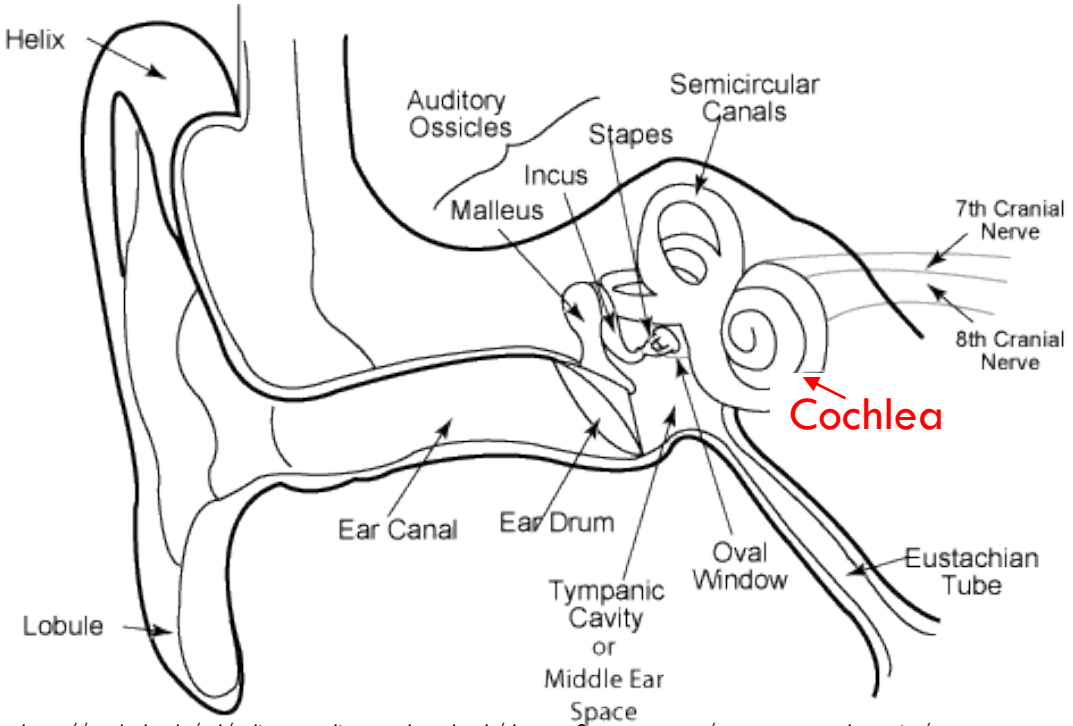
- **Spectrogram**: Shows frequencies in sounds over time.



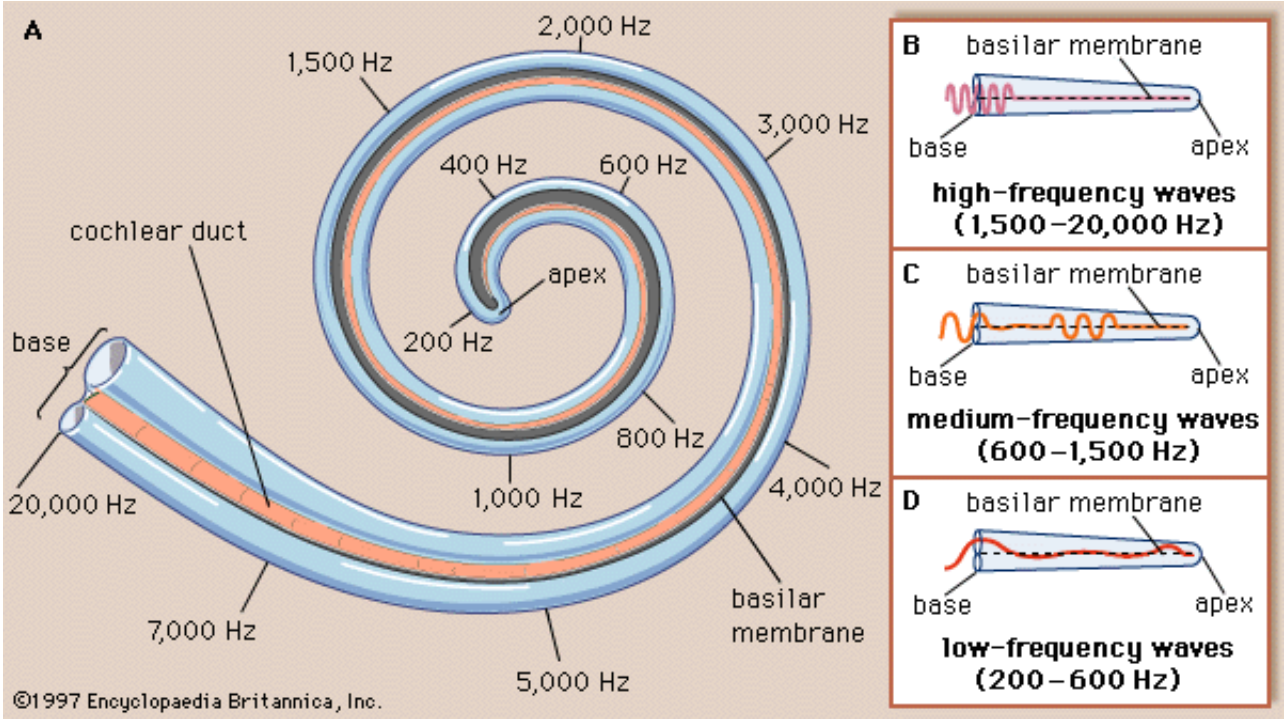
https://www.discovermagazine.com/health/detecting-autism-risk-in-baby-babbles

Transduction of Sound

- The ear breaks sounds down by frequency too



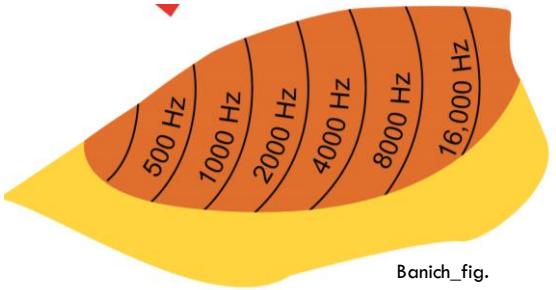
https://med.uth.edu/orl/online-ear-disease-photo-book/chapter-3-ear-anatomy/ear-anatomy-schematics/



https://www.britannica.com/science/ear/Transmission-of-sound-within-the-inner-ear#/media/1/175622/537

Auditory Pathway

- Early auditory processing
  - Brainstem
  - Inferior colliculus
  - Medial geniculate nucleus
  - Primary auditory cortex



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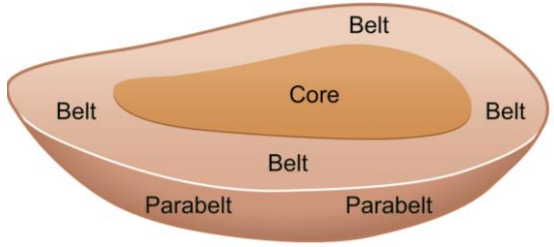
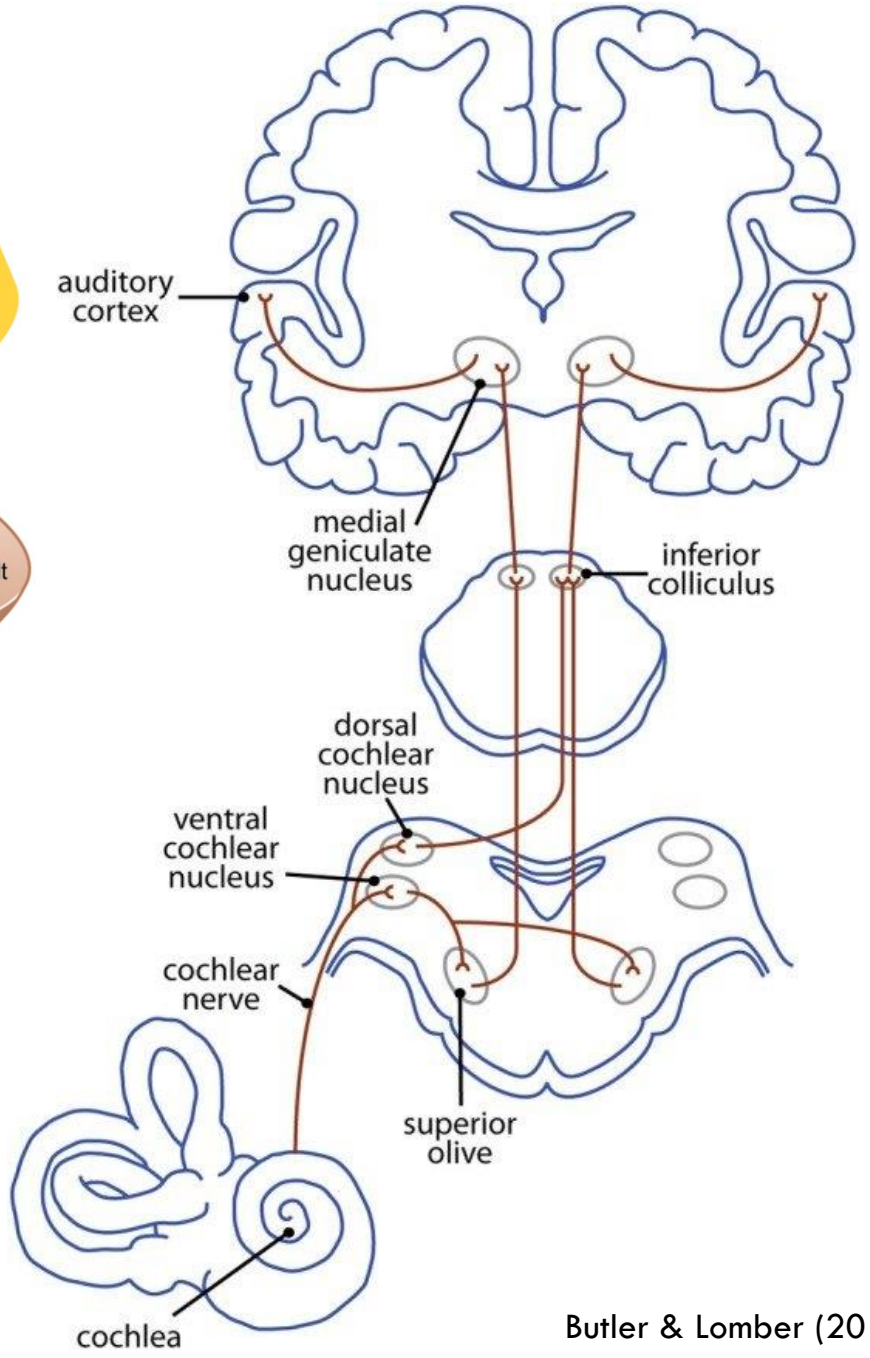


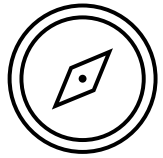
- Primary auditory cortex (A1) is tonotopically mapped

- Belt & parabelt process more complex sounds, patterns (vocalizations)



Butler & Lomber (2013)

Challenges in Speech Perception



- Ambiguity (one-to-many)
- Invariance (many-to-one)
- Context & expectancies
- AND segmentation

- Integrate knowledge with sensory and motor systems
  - Similarities to visual recognition
  - Hierarchical (later)
  - Time sensitive (later)

What is the primary distinction between the ventral and dorsal visual processing streams?

Ventral: Lower hierarchy; Dorsal: Upper hierarchy

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Dual-Stream Model

- Segregation of function (what/how)
- Integration across modalities
- Bidirectional flow within and between streams

Hickock & Poeppel, 2007