Learning and Adaptation in Spoken Communication

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Thanks to:

- Ingrid Johnsrude
- Alexis Hervais-Adelman
- Dennis Norris
- William Marslen-Wilson

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Outline:

- Successful communication requires adaptive processes from speakers and listeners

- Speech comprehension involves top-down, perceptual-learning processes to adjust to novel sounding input

- Distinguishing top-down from bottom-up processes requires multimodal imaging with high temporal- and spatial-resolution

Sine-Wave Speech
Remez et al., (1981; 1994; 2001)
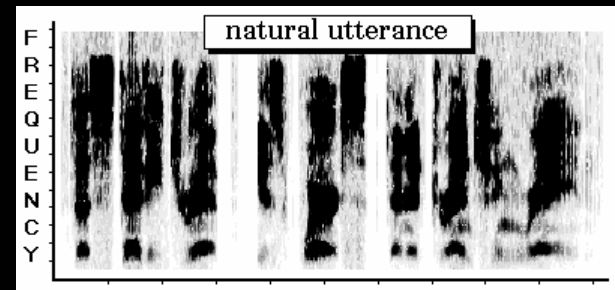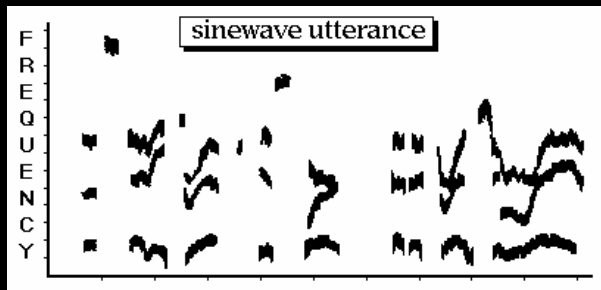
Perceptual Learning in Comprehension

- What you can understand from speech depends on:
  - the sound that you hear
  - whether you know what is being said
  - your experience of a particular form of speech
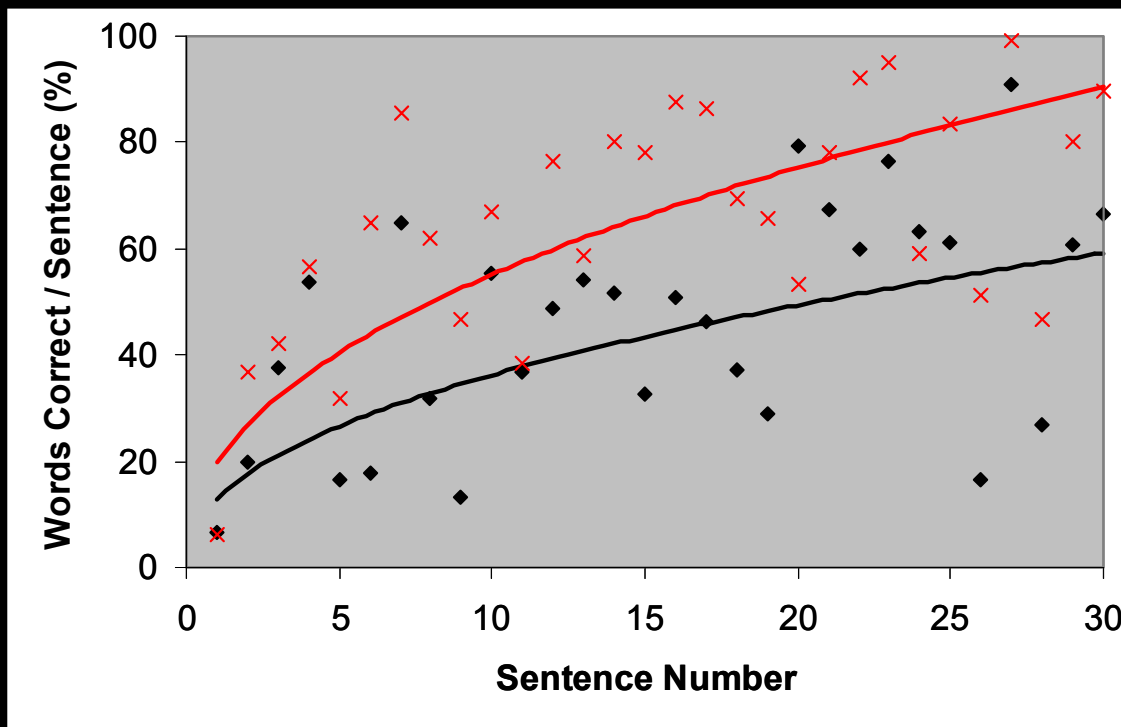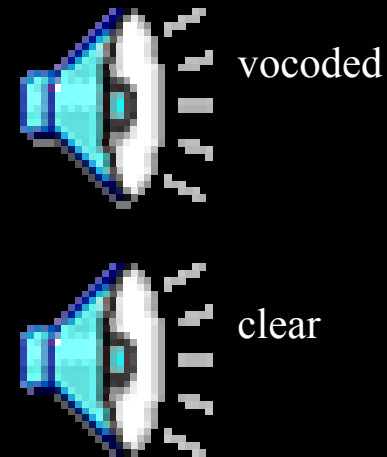
Perceptual Learning in Comprehension

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…and take a cast net and your oil clothes and go down there, go down over that bank at Lance Cove, and catch that tub of caplin and bring it up on the bank and get a smoke, and then put it on your back, in the dark, coming across the hills, all those rocks that you went through….
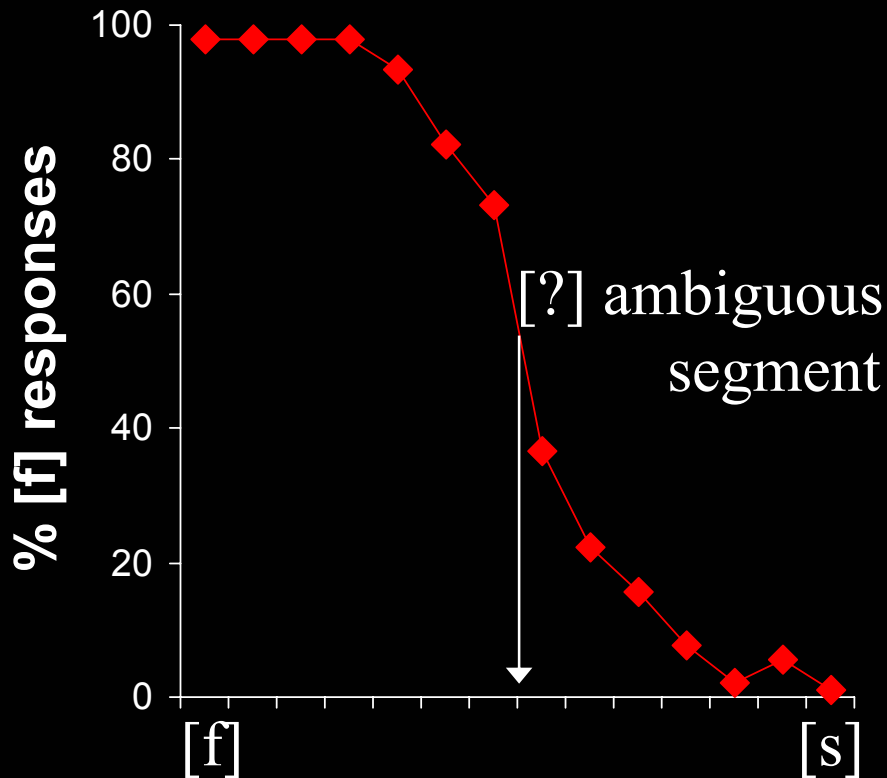
Perceptual learning produces
rapid changes through top-down processes:

- Understanding noise-vocoded speech
  (*Davis, Hervais-Adelman & Johnsrude, submitted*)|

vocoded

clear

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- ## Learning phoneme categories
  (*Norris, McQueen & Cutler, 2003*)

% [f] responses

100 · 80 · 60 · 40 · 20 · 0

[f]   [s]

[?] ambiguous segment

Four Training Conditions:

Group 1:   *cliff* /klI?/, *beef* /bi:?/, *kiss* /kIs/, *peace* /pi:s/,
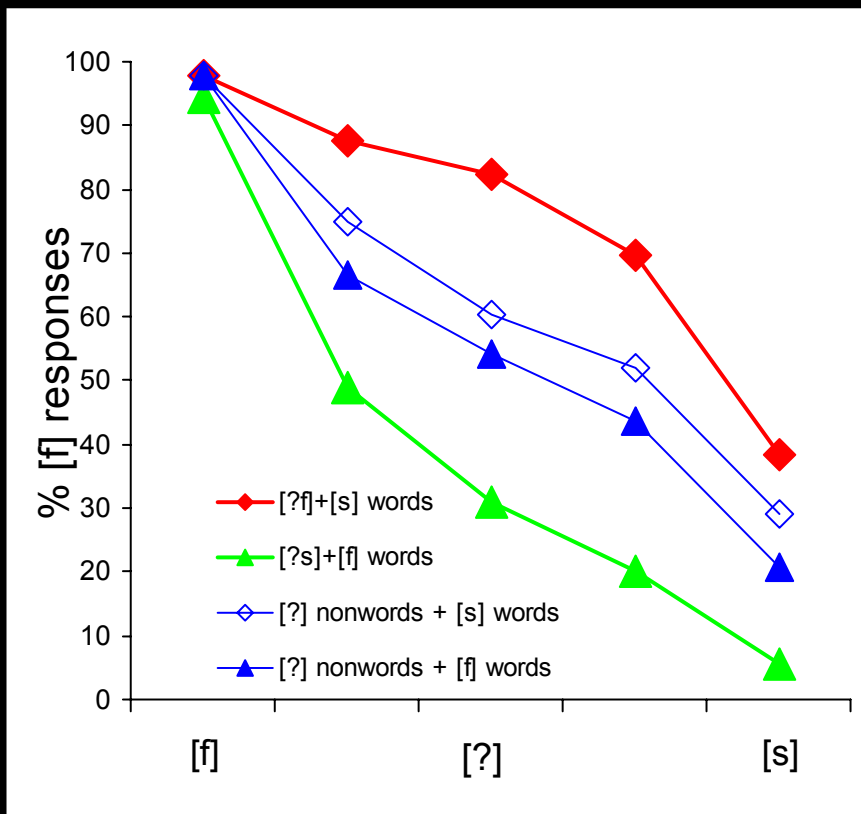
Group 2:   *kiss* /kI?/, *peace* /pi:?/, *cliff* /klIf/, *beef* /bi:f/

Control 1:   *driff* /drI?/, meef /mi:?/, *kiss* /kIs/, *peace* /pi:s/

Control 2:   *driss* /drI?/, meace /mi:?/, *cliff* /klIf/, *beef* /bi:s/

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Legend:
- [?f]+[s] words
- [?s]+[f] words
- [?] nonwords + [s] words
- [?] nonwords + [f] words

Y-axis: % [f] responses (0 to 100)
X-axis: [f], [?], [s]

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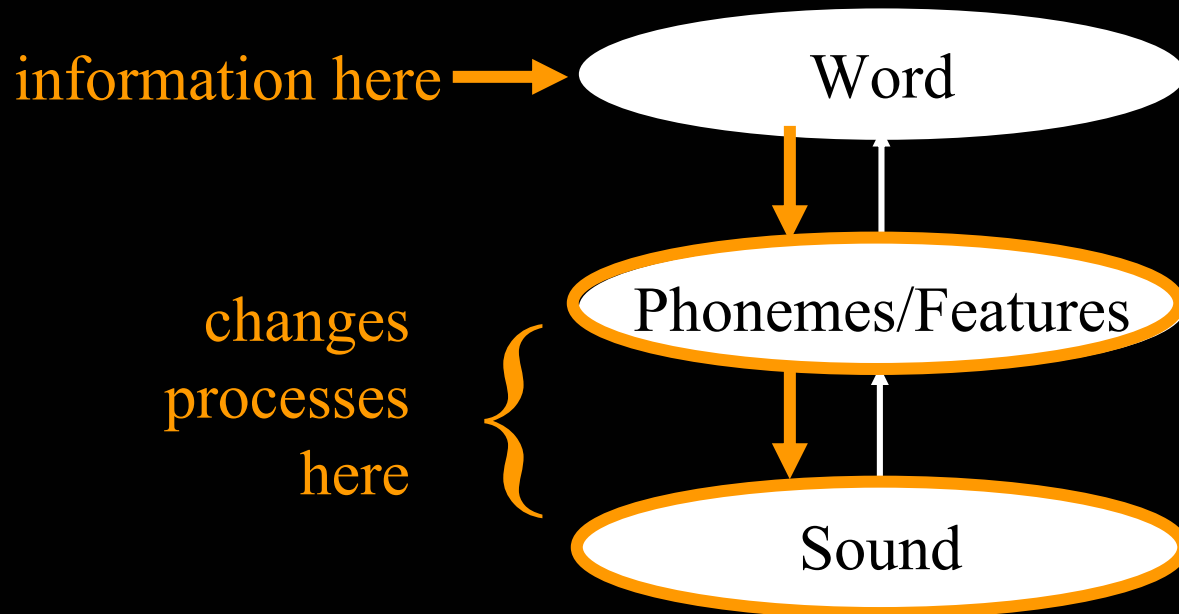
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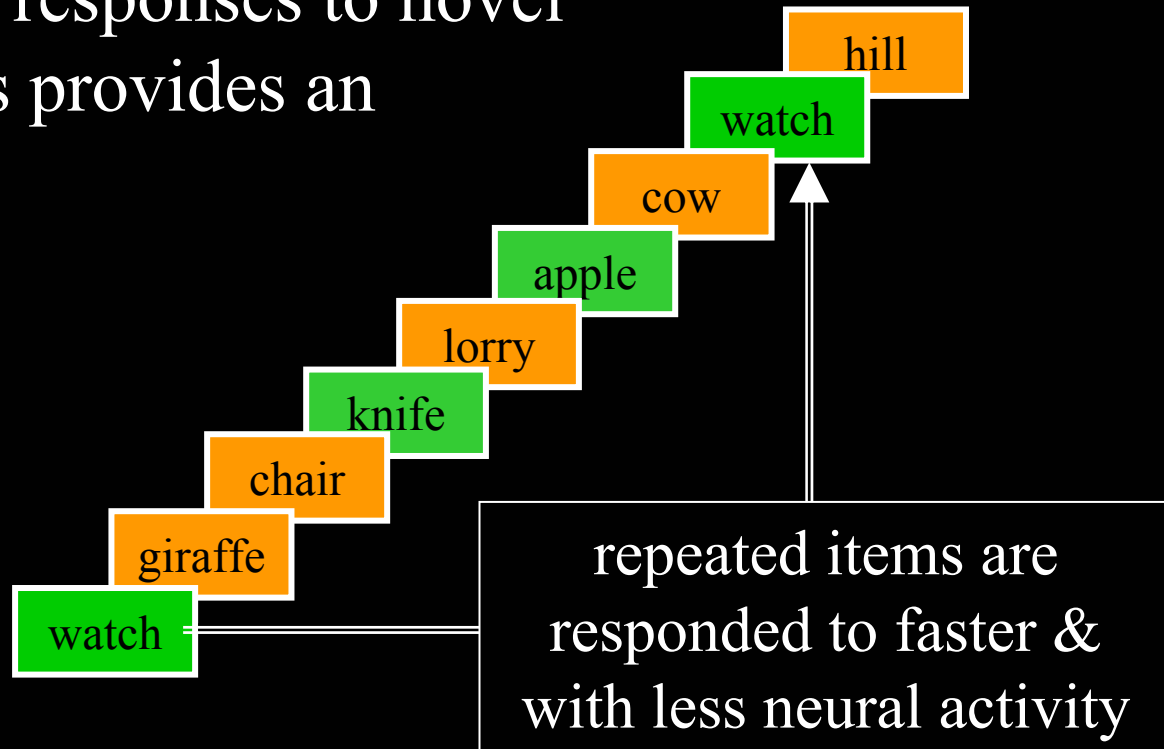
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information here ➔ [**Word**]

changes
processes
here }

[**Phonemes/Features**]

[**Sound**]

Identifying learning processes in the brain

- Repetition priming is a simple form of learning
  (*Henson, 2004*)

- Contrasting neural responses to novel and repeated events provides an index of learning
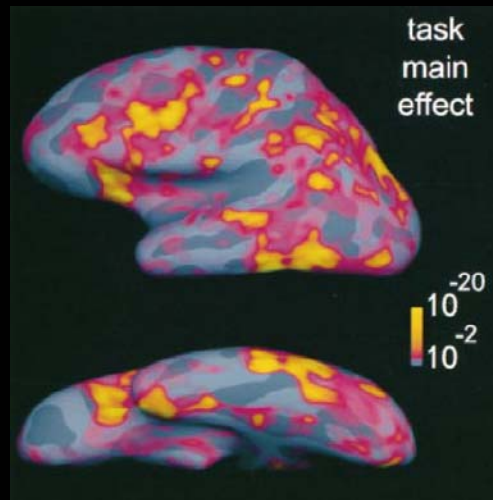
  (*e.g. Henson; Dale*)

hill

watch

cow

apple

lorry

knife

chair

giraffe

watch

repeated items are responded to faster & with less neural activity
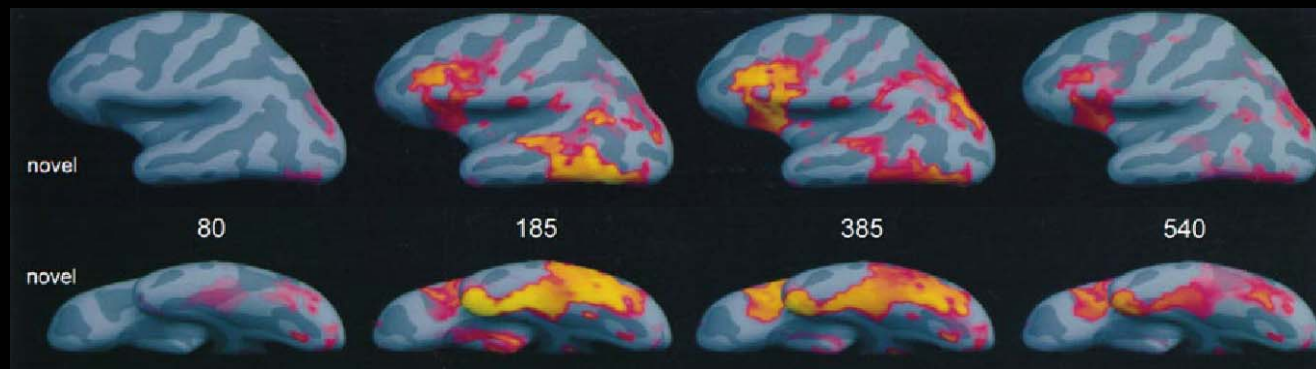
Dale et al., (2000)
fMRI / MEG of Visual Repetition Priming

- Words presented for semantic (size) judgement
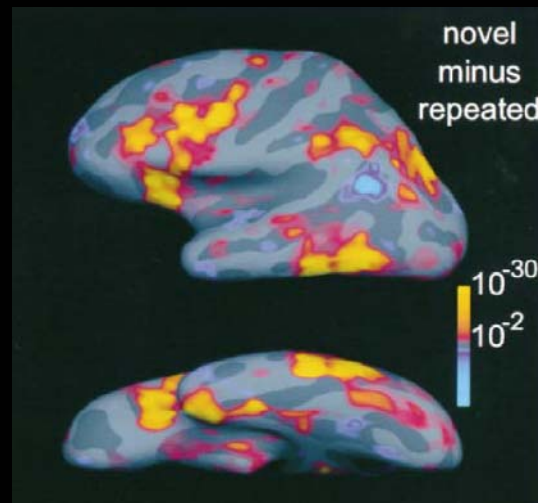
- fMRI

- MEG

(constrained by fMRI)

Dale et al., (2000)
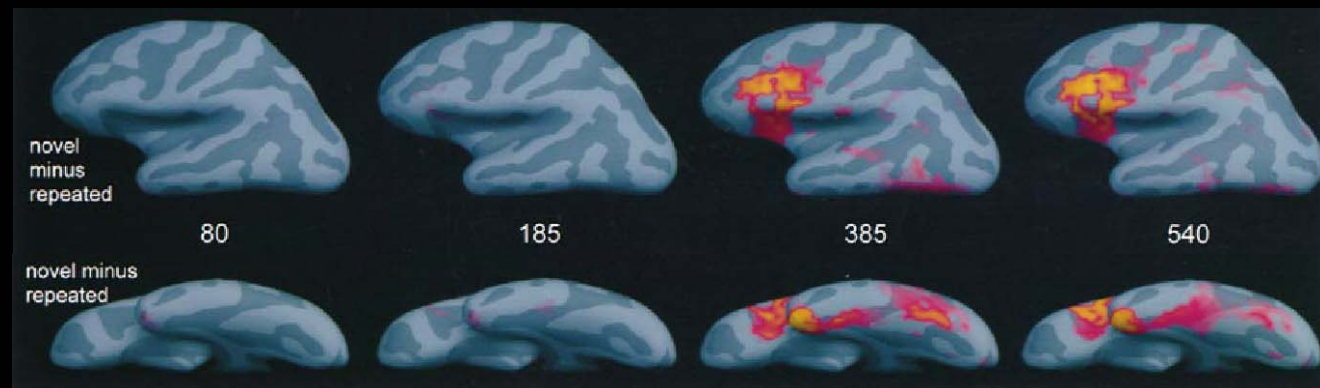# fMRI / MEG of Visual Repetition Priming

- Contrast of novel vs repeated words shows priming

- fMRI

Results suggest a late, top-down response is absent from second (repeated) presentations

- MEG
(constrained by fMRI)

Summary:

- Human communication is robust due to rapid, top-down learning processes during comprehension

- Neural systems involved in learning are beginning to be explored using multi-modal imaging

- Understanding the neural mechanisms involved in these learning processes may assist in building artificial systems that are similarly powerful and flexible

Thank You