AUDITORY CORTEX PROCESSING STREAMS:
How are they relevant to signal separation?

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Signal separation: what are the neural processes?

It may depend on the nature of the task:
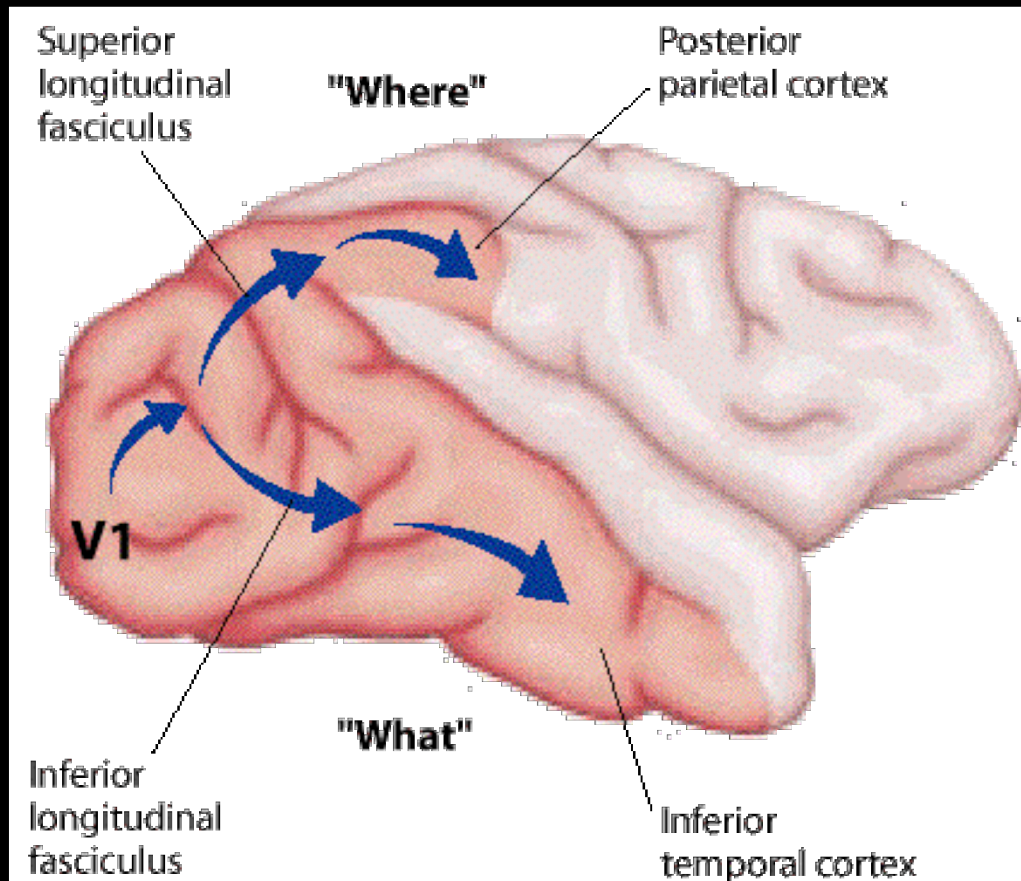Following a temporal pattern
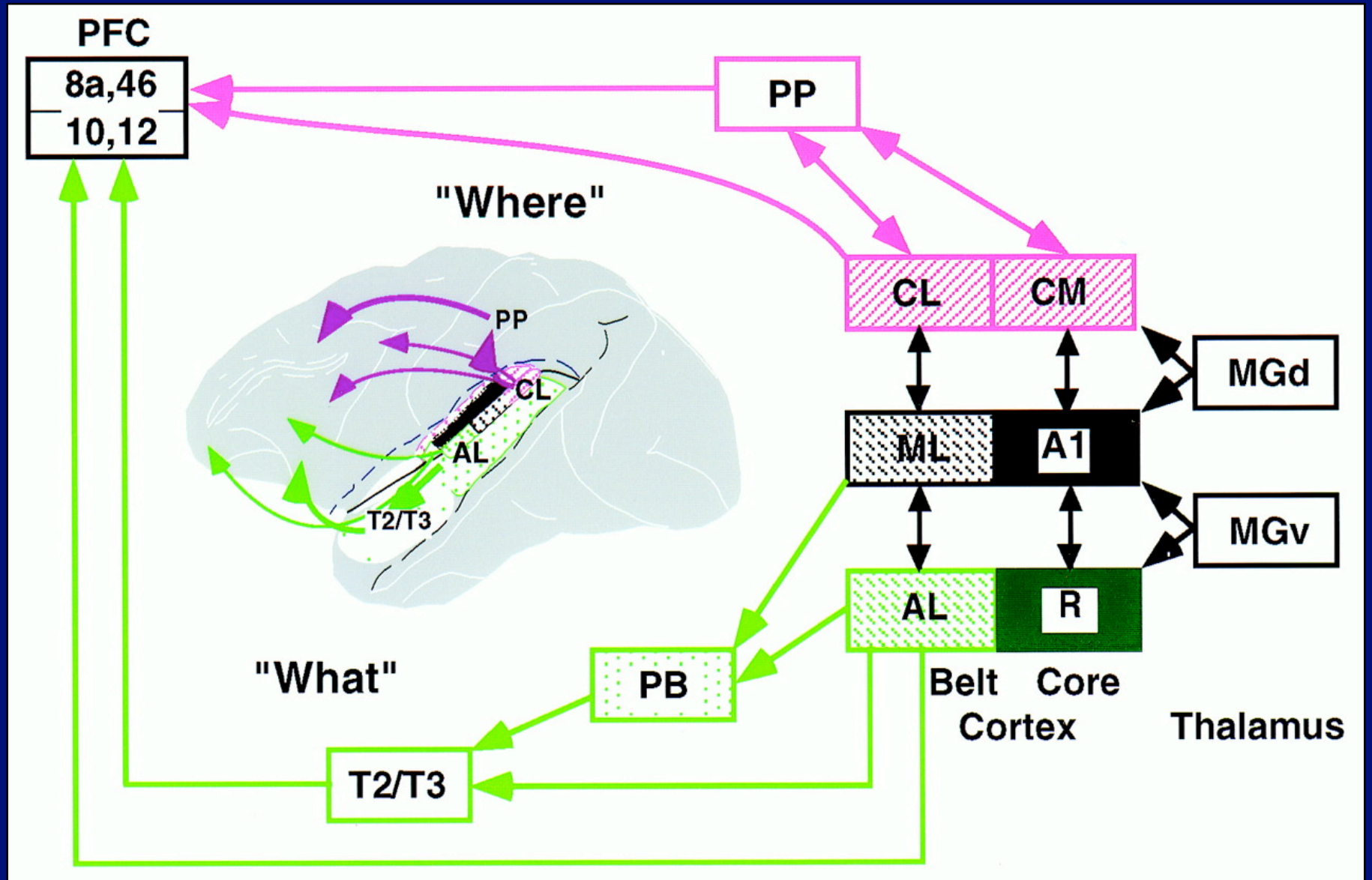Spatial segregation
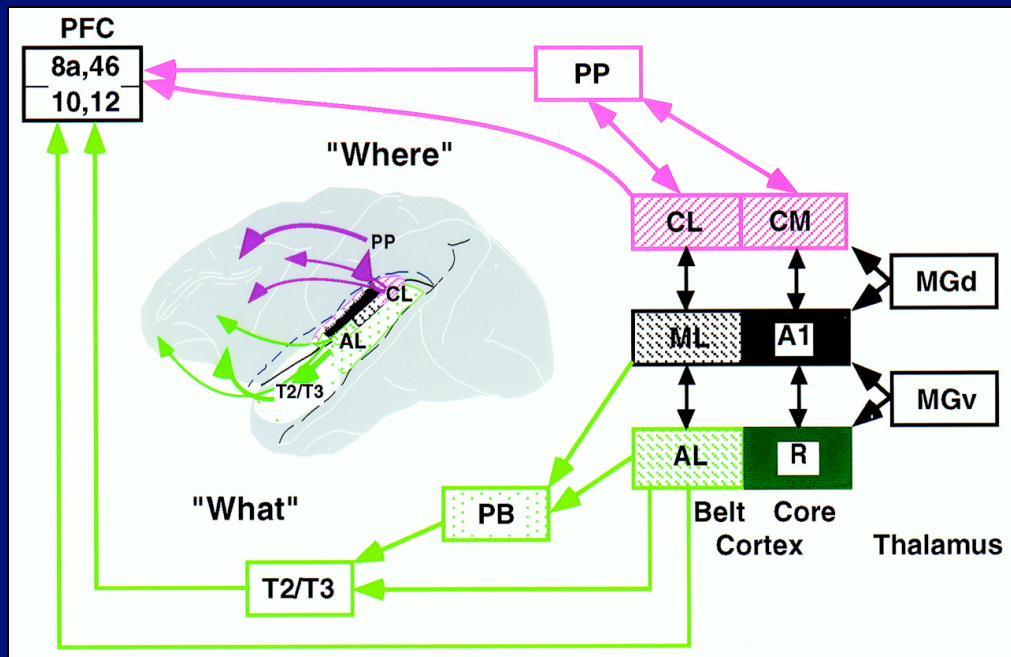Identification of a source

…

Understanding the neural pathways involved may help us to figure out the computations (and vice-versa)

Cortical Visual Areas: Two Processing Streams

- functional specialization: V4 (color), V5/MT (motion), etc.

- *where* system: V1 to posterior parietal cortex (7a)

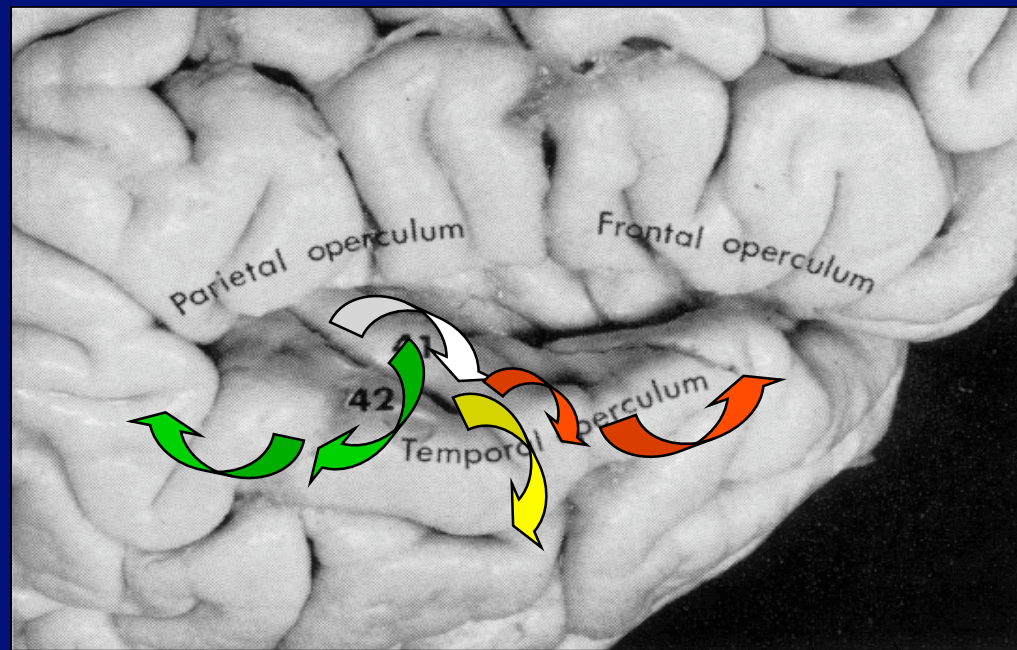- *what* system: V1 to inferotemporal cortex (TE)

Superior longitudinal fasciculus

"Where"

Posterior parietal cortex

V1

Inferior longitudinal fasciculus

"What"

Inferior temporal cortex

Rauschecker & Tian, *PNAS*, 2000

Rauschecker & Tian *PNAS*, 2001

But we don't know
how many there are
or what they do…

If we make an analogy with the visual system, then:

Posterior stream: is concerned with *changes* in energy

distribution over sensory epithelium

Anterior stream: is concerned with *object-related* features

Cognitively, this may relate to the distinction between
HOW a sound is evolving in time vs.
WHAT is making the sound

Distinction between information-bearing patterns (melodies, speech)

vs. object as sound source (unique origin: instrument, voice…)

Pattern: discard differences across exemplars; process *relational* information

Source: discard pattern and extract *invariant* features in signal characteristic of that source
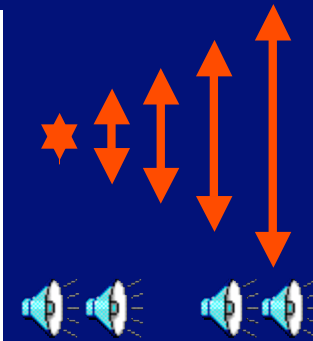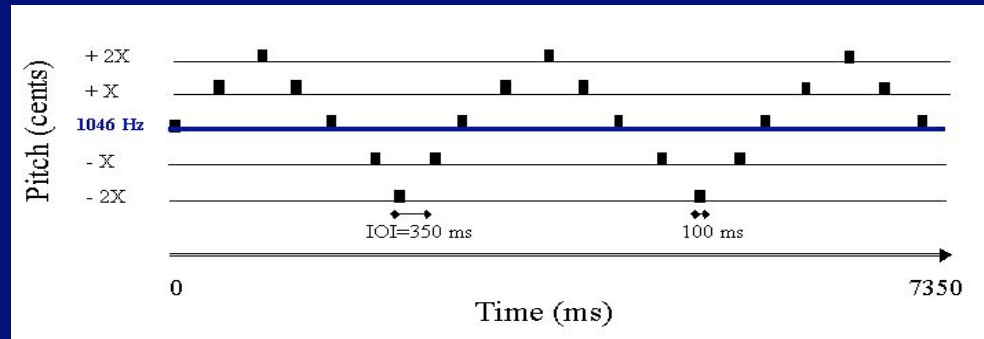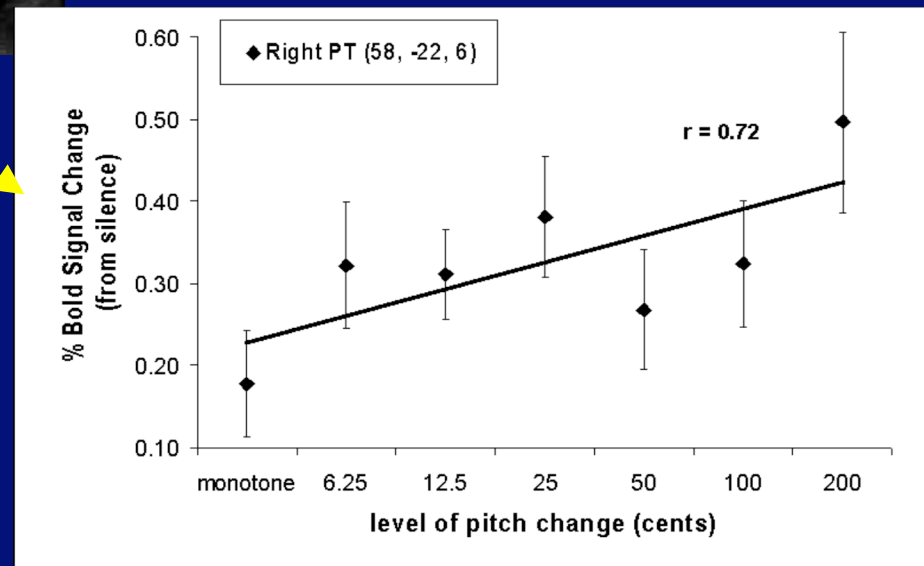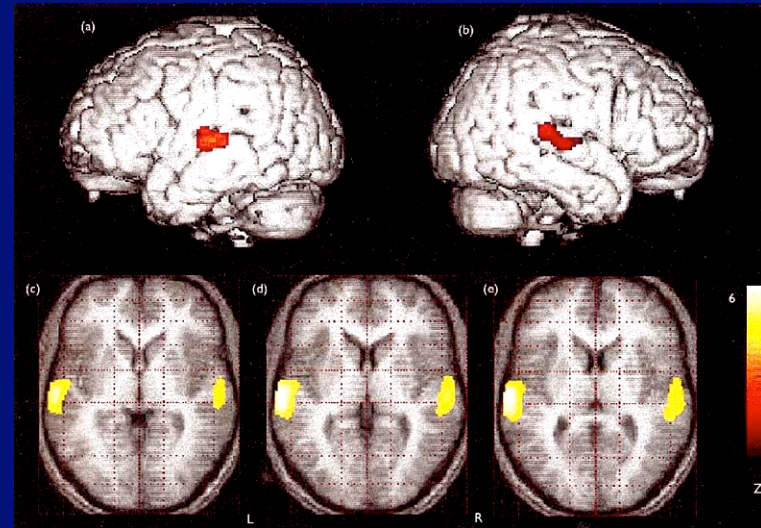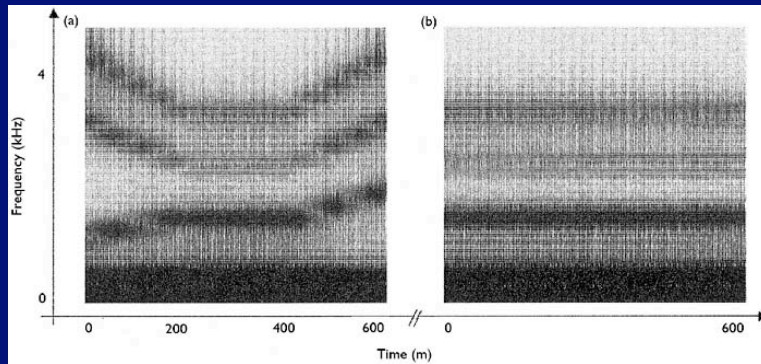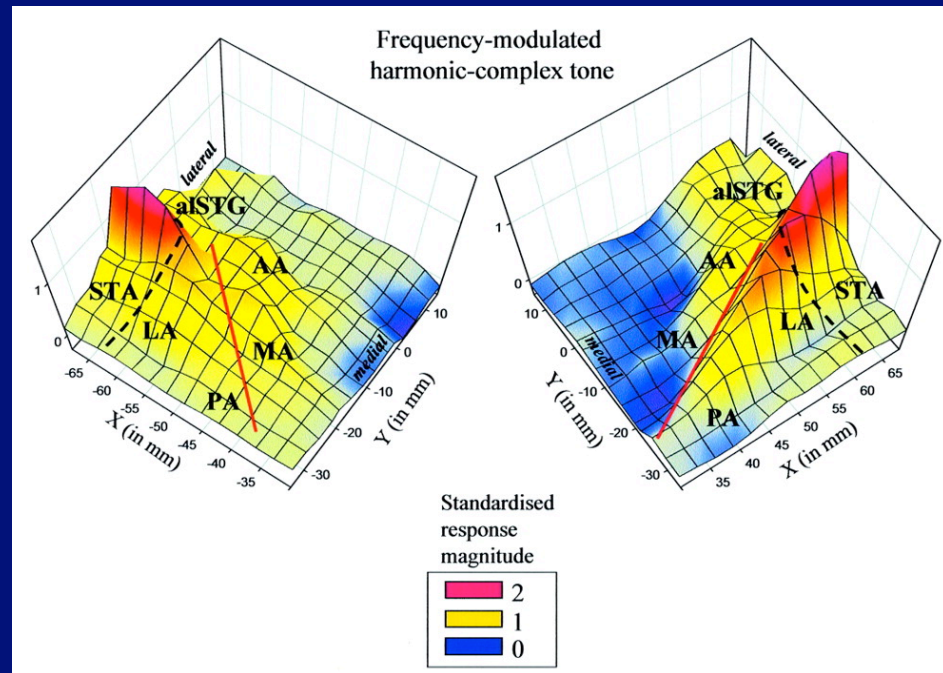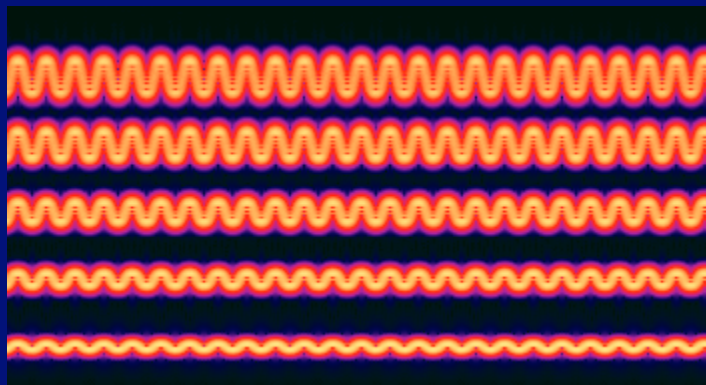
Sensitivity to pitch change
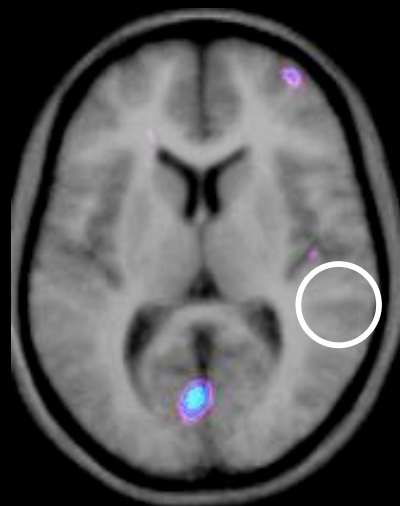
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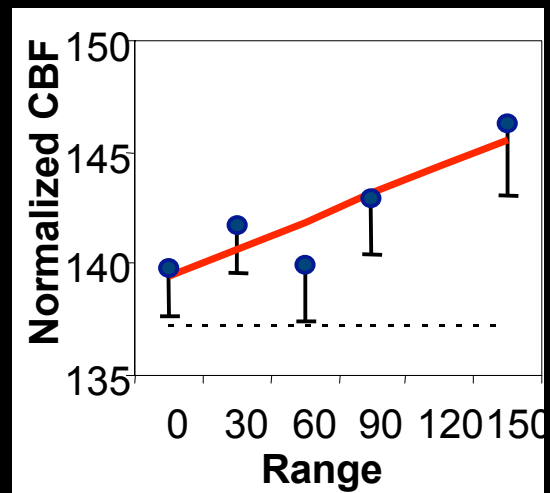
(Hyde, Zatorre & Peretz, OHBM 2003)
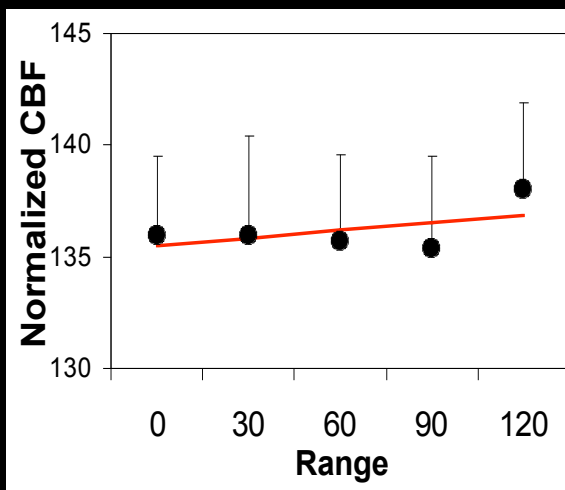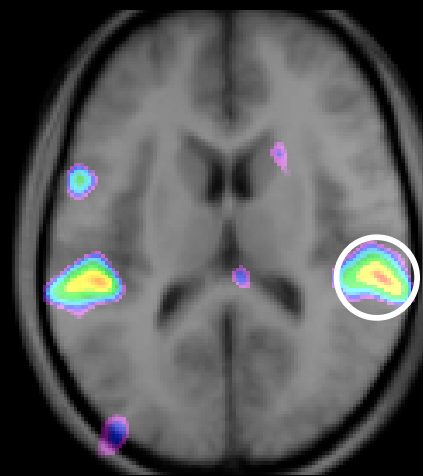
Examples:
Spectral motion (Thivard et al., 2000)
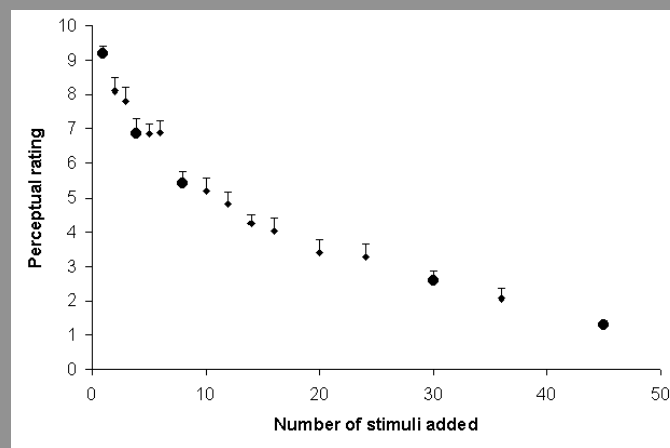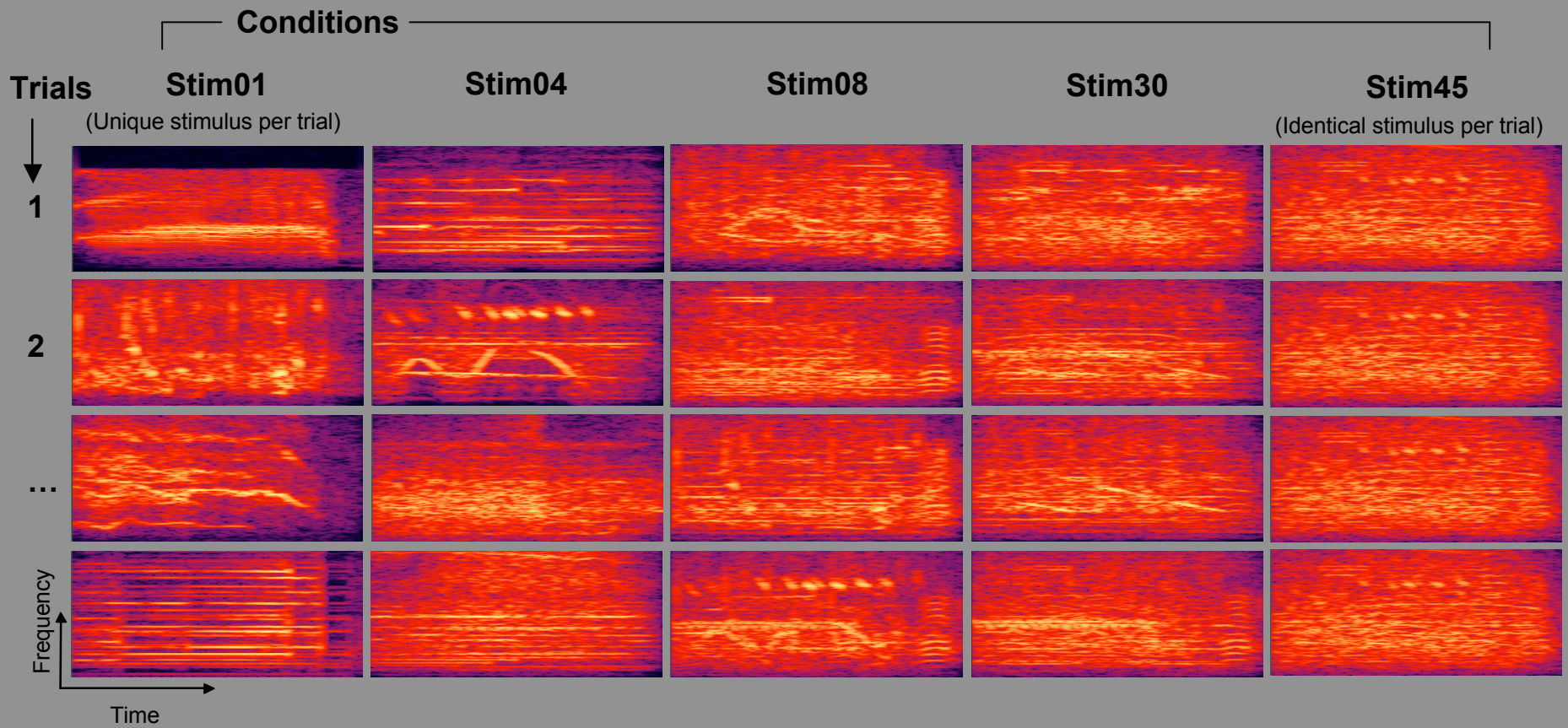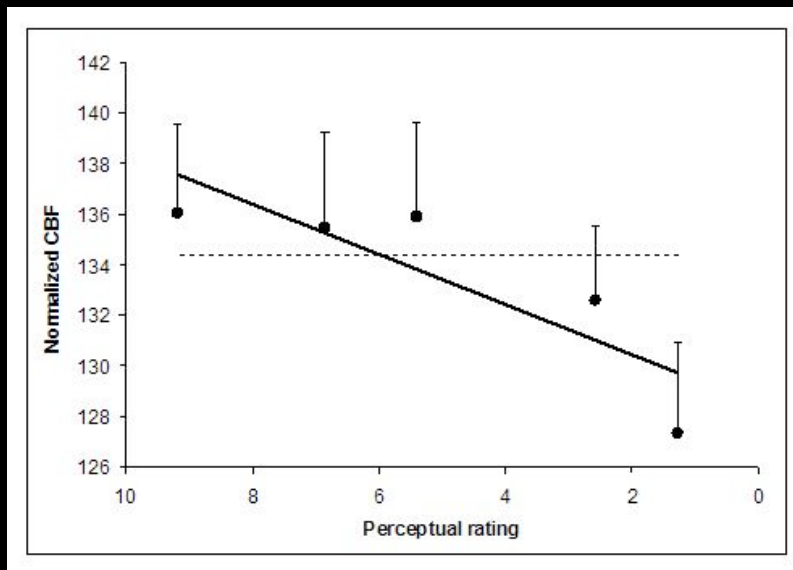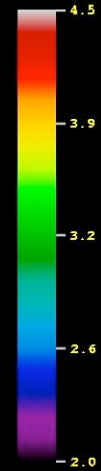

FM vs stationary tones
(Hall et al., 2002)

Sequential sounds

Simultaneous sounds

Conditions

Trials

	Stim01	Stim04	Stim08	Stim30	Stim45
	(Unique stimulus per trial)				(Identical stimulus per trial)

1

2

...

Frequency

Time

Perceptual rating

Number of stimuli added

Covariation Analysis

z = -4

y = -12

x = 59
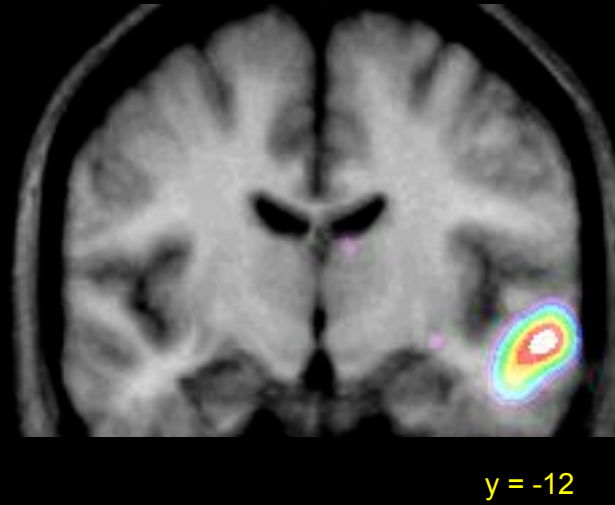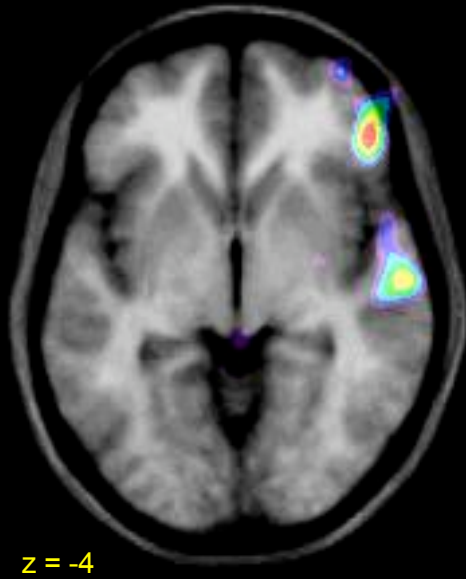
(Zatorre et al., *J Neurosci.* 2004)

Many speakers (one word) vs Many words (one speaker)

(Belin & Zatorre, *NeuroReport* 2003)
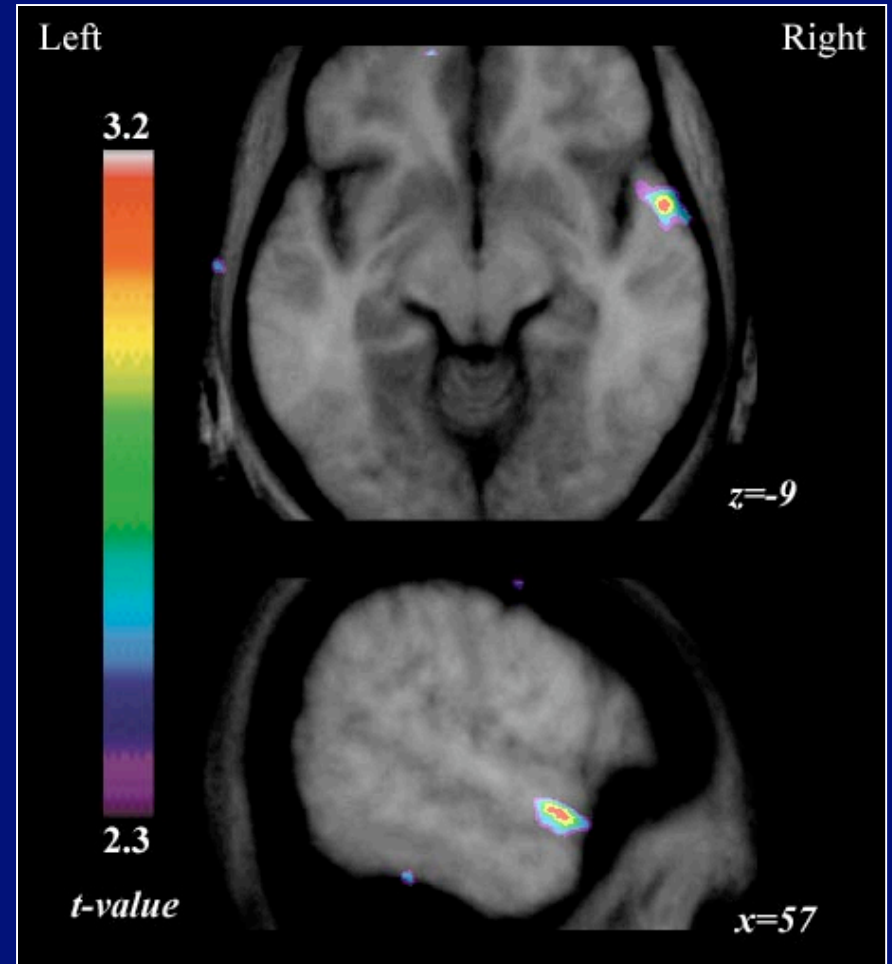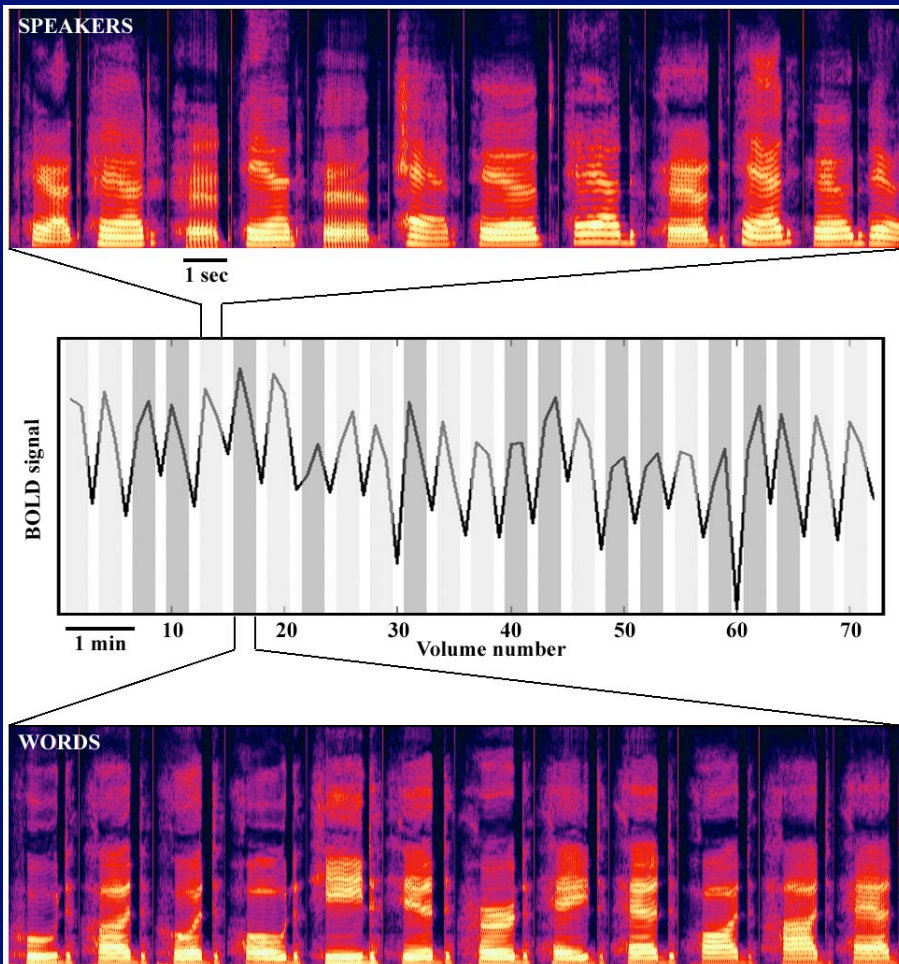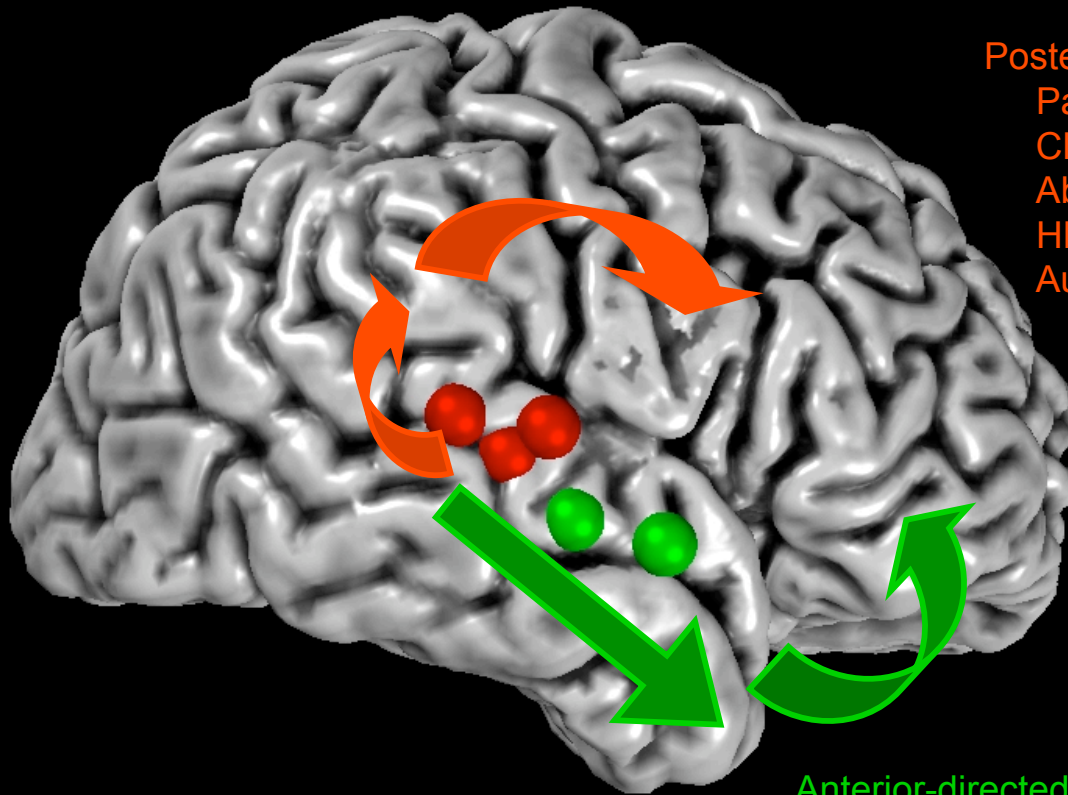
Posterior-directed stream:
Pattern analysis/identification
Change in sound over time (motion)
Abstraction of relations between elements
HRTF convolutions
Auditory-motor interface

Anterior-directed stream:
Source analysis/identification
Abstraction of characteristic features
Object constancy
Interaction with visual object stream

Advantages:

   more consistent with analogy to visual processing streams

   respects cognitive distinction between pattern vs source

   results in readily testable predictions

Relevance to segregation question:

   Different computations carried out in different streams may be involved depending on the circumstances