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)
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

(z = 6, y = -22)

(Hyde, Zatorre & Peretz, OHBM 2003)
Examples:
Spectral motion (Thivard et al., 2000)

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

Frequency

Trials

(Unique stimulus per trial)

1

2

…

(Identical stimulus per trial)

Conditions

Trials | Stim01 | Stim04 | Stim08 | Stim30 | Stim45
---|---|---|---|---|---
1 |  |  |  |  |  
2 |  |  |  |  |  
… |  |  |  |  |  

Graph: Perceptual rating vs. Number of stimuli added
Covariation Analysis

$z = -4$

$y = -12$

$x = 59$

$r = 0.87$

(Zatorre et al., *J Neurosci*. 2004)
Many speakers (one word) vs Many words (one speaker)

(Belin & Zatorre, NeuroReport 2003)
Anterior-directed stream:
- Source analysis/identification
- Abstraction of characteristic features
- Object constancy
- Interaction with visual object stream

Posterior-directed stream:
- Pattern analysis/identification
- Change in sound over time (motion)
- Abstraction of relations between elements
- HRTF convolutions
- Auditory-motor interface
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