## Integration of Syntax and Semantics

- People do their best to combine syntactic and semantic information to interpret sentences
- Complete the sentence
  - (a) If you walk too near the runway, landing planes are
  - (b) If you've been trained as a pilot, landing planes are
  - (Tyler & Marslen-Wilson)

- Took people longer to complete (b) than (a)
- Suggests meaning of sentence is used to disambiguate the phrase "landing planes"

Language Production

- Broca's Area (1861)
- Difficulty in speech production
- Loss of ability to repeat speech
- Comprehension intact
- Foot of 3rd frontal convolution (BA 44)
- Left hemisphere (1865)
  - Except left handers
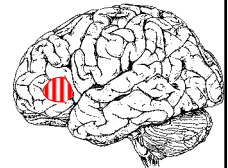
Language Comprehension

- Wernicke's Area (1874)
- Normal production (speech sounds and fluent nonsense)
- Unaware of deficit
- Impaired comprehension
- Left hemisphere
- Superior temporal gyrus (BA 42, 22)
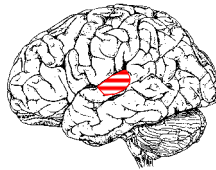
Aphasia notes

- Anomic: problem naming objects
- Paraphasia: use of related but inappropriate words
  - Semantic: 'fork' when 'knife' is meant
  - Phonemic: 'fork' when 'stork' is meant
- Neologism: literally "new word," using word that bears no obvious relation to a recognizable word. e.g., "glester"
- Paragrammatic: incorrect use of grammatical function words. e.g., "he is always brillianting"

Comprehension

- Recognize Word
  - Phonological Info
  - Visual Info
- Retrieve Information
  - Syntactic Info
  - Semantic/Pragmatic Info
- Integrate Syntactic & Semantic/Pragmatic Info
- Store Gist Representation

Why speech perception is hard

- Rapid Rate
  - 15 phonemes/second
    - 67 ms/phoneme
  - 50 phonemes/second
    - 20 ms/phoneme
- Absence of Clear Boundaries
  - No "white space" as sounds blend into one another
  - Silence only for stop consonants and pauses
  - Parallel transmission or co-articulation
- Variability
  - Across speakers
  - Across registers
    - Yelled/Whispered/Sung
  - Across words
    - delight
    - dapper
    - dubious
- Low Quality of Information
  - 50% of words in normal speech unintelligible when presented in isolation

Absence of Clear Boundaries
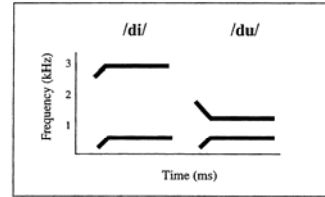
"I owe you."
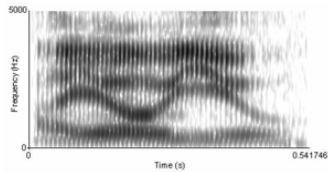
Variability across Words

Figure 1 Formant patterns for simplified versions of /di/ and /du/. Note that the transition of the second formant (i.e., the one higher in frequency) differs dramatically for the two syllables. Nonetheless, the consonant in both cases is perceived as /d/. The first formant trajectory, which is equivalent in both syllables, is not informative about place of articulation and would be the same for /b/ and /g/ initial syllables. (Adapted from Delattre et al. 1952.)

Coarticulation
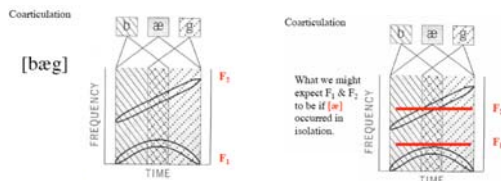
- Movements of articulators for different phonemes overlaps in time and interacts with one another
- Vocal tract configuration at any time is influenced by production of >1 phone
- Acoustically this means that each phonetic segment is influenced by the production of neighboring phones

Coarticulation
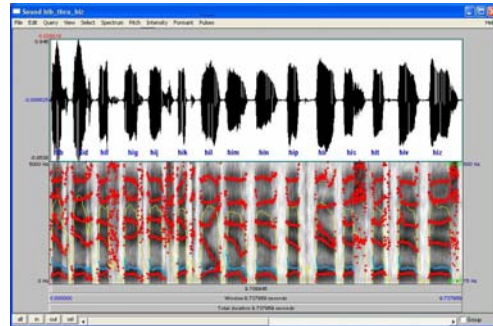
Theories of Speech Perception

- Motor Theory (Liberman)
    - Close link between perception and production of speech
        - Use motor information to compensate for lack of invariants in speech signal
        - Determine which articulatory gesture was made, infer phoneme
    - Human speech perception is an innate, species-specific skill
        - Because only humans can produce speech, only humans can perceive it as a sequence of phonemes
        - Speech is special
- Auditory Theory
    - Derives from general properties of the auditory system
    - Speech perception is not species-specific
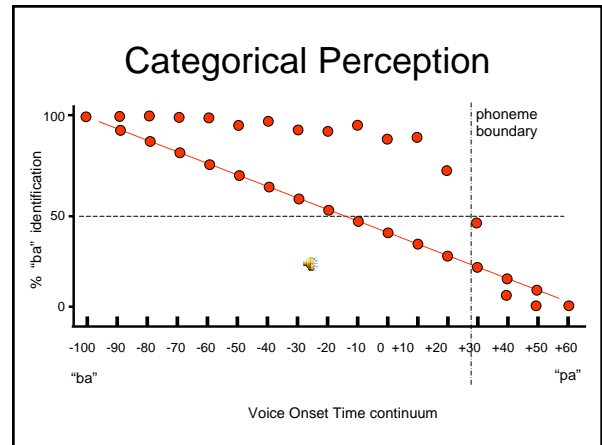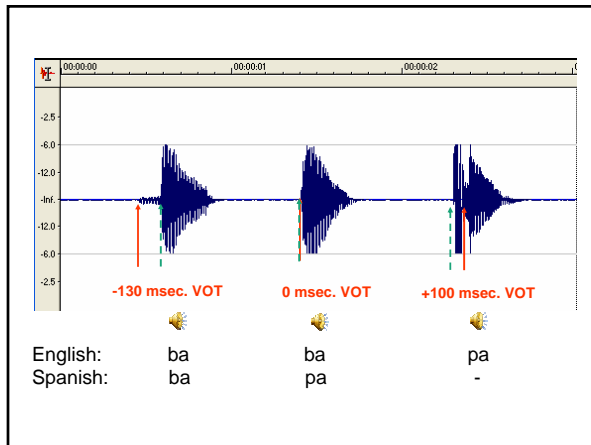
How the speech module works:

…"the candidate signal descriptions are computed by an analogue of the production process—an internal, innately specified vocal-tract synthesizer…—that incorporates complete information about the anatomical and physiological characteristics of the vocal tract and also about the articulatory and acoustic consequences of linguistically significant gestures" (Liberman & Mattingly, 1985, p. 26).
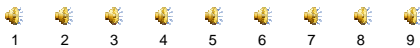
Empirical Evidence

- Knowledge of Articulatory Constraints seems to guide speech perception
  - Acoustic characteristics not constant across phones
  - [ba] confused with [da] but not with [sa]
  - Rated similarity between phonemes depends on number of shared articulatory features

Categorical Perception

- Categorization
  - Play sounds varying between [ba] and [pa] and ask people to categorize as [ba] or [pa]
  - Sounds identified as a [b] or a [p] in an unambiguous way
  - Only variability was when VOT between 20 and 40 ms
- Discrimination
  - Play pairs of sounds varying between [ba] and [pa] and ask people if the sounds are the *same* or *different*
  - People cannot discriminate between different [b] sounds that vary in VOT from –150-0
  - Can accurately discriminate between [b] and [p] even in narrow VOT ranges
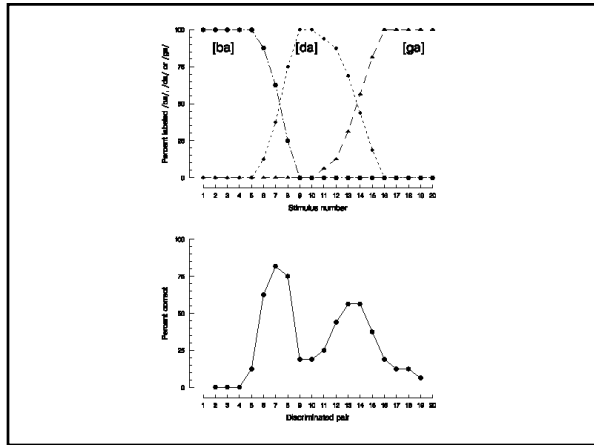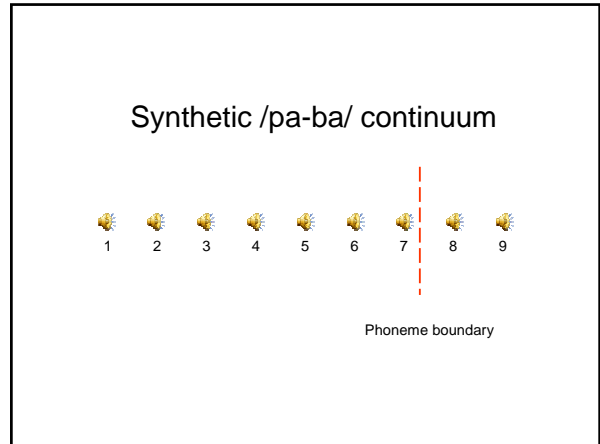

	-130 msec. VOT	0 msec. VOT	+100 msec. VOT
English:	ba	ba	pa
Spanish:	ba	pa	-

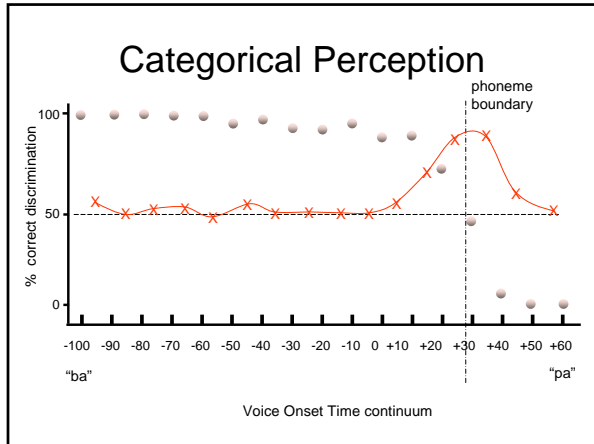## Categorical Perception

Synthetic /pa-ba/ continuum

1 2 3 4 5 6 7 8 9

Discrimination task

- Hear 2 adjacent (i.e., very similar) stimuli

- Task: Are they the Same? Different?

Categorical Perception

% correct discrimination vs Voice Onset Time continuum ("ba" ... "pa"), showing phoneme boundary at +30.

Synthetic /pa-ba/ continuum

1 2 3 4 5 6 7 8 9

Phoneme boundary

Percent labeled /ba/, /da/ or /ga/ for [ba], [da], [ga] across stimulus number; Percent correct across discriminated pair.

Is categorical perception innate?

Infant's sucking rate correlates with arousal:

- sucking rate drops when infant is bored
- sucking rate picks up if infant is aroused (made alert by some change in the environment)