CATEGORICAL PERCEPTION IN COCHLEAR IMPLANT USERS: PRELIMINARY RESULTS

What categories are we talking about?

- Phoneme categories
  - Descriptive linguistics
    - Method of segmentation and classification
      - Phonology
      - Morphology
      - Syntax
      - Semantics

Characteristics of Categorical Perception (CP) for speech

- Sharp boundaries between categories indicated by performance on identification task
- Stimuli within the same category are difficult to discriminate
- Stimuli from different categories are easy to discriminate

- CP facilitates listeners' ability to
  - Overlook non-contrastive acoustic (allophonic) differences within consonant phonemes (esp. stops and fricatives)
  - Recognize speech (and acquire language).

- CP is not unique to
  - Speech
  - Audition
  - Humans
- In general, CP facilitates the recognition of sensory data

GOALS

- Investigate perception of acoustic cues to voicing and place of articulation
  - Voicing
    - Voice onset time (VOT) in initial stop consonants
    - Voicing contrast along /b - p/ continuum
  - Place
    - Second formant (F2) transition in initial stop consonants
    - Place of articulation contrasts along /b - d/ continuum

Method

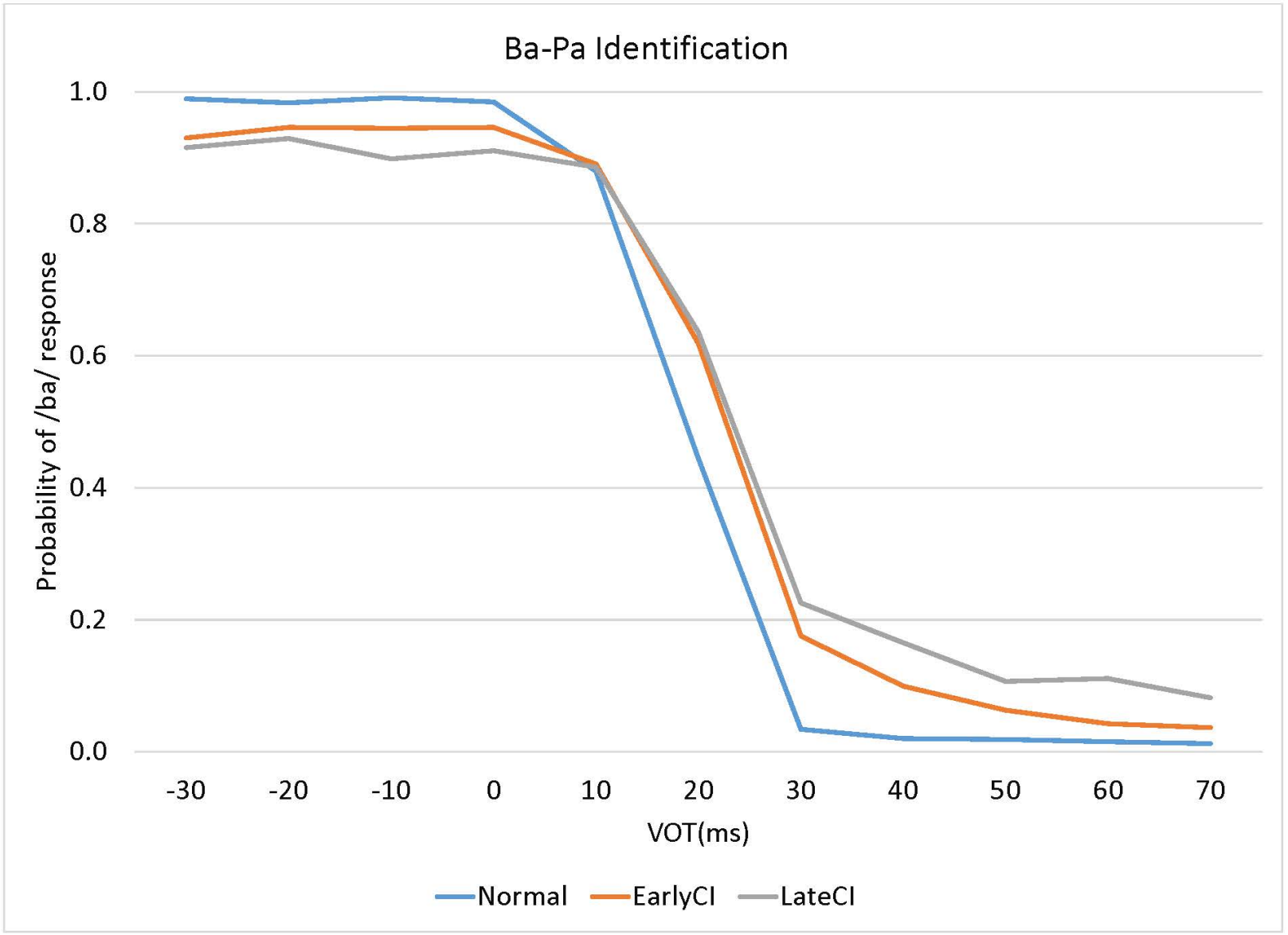
- Participants
  - Early Group (N=19) – implanted before age 4
  - Late Group (N=18) – implanted after age 7
  - Normal Hearing Group (N=18)
  - Both CI Groups became Deaf before age 3
- Tasks
  - ABX discrimination – 576 trials per continuum
  - Identification – 396 trials per continuum
  - NTID Speech Recognition Test (NSRT)
  - Each participant completed two continua (1,152 discrimination trials and 792 identification trials)

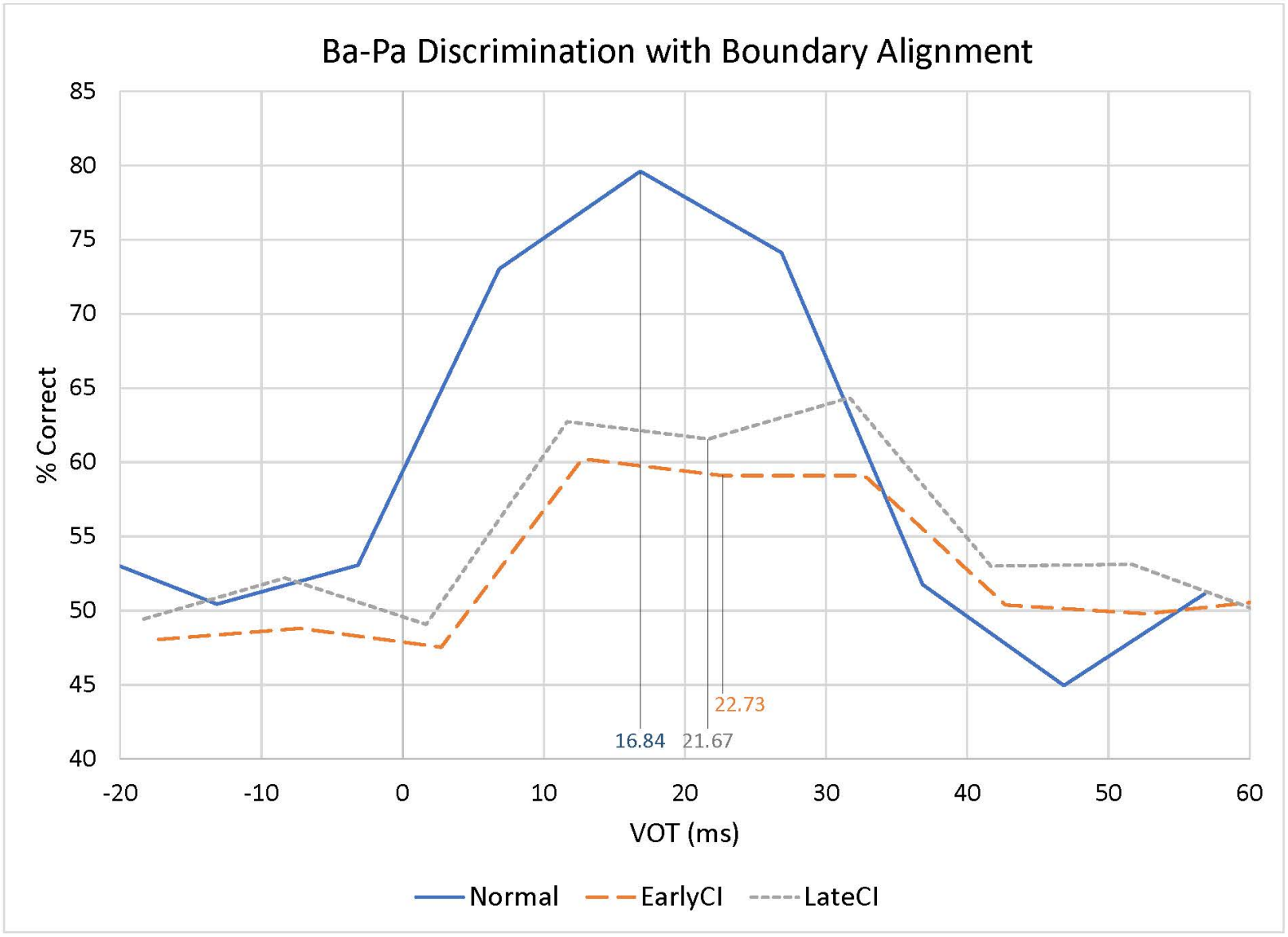
Method (cont'd)

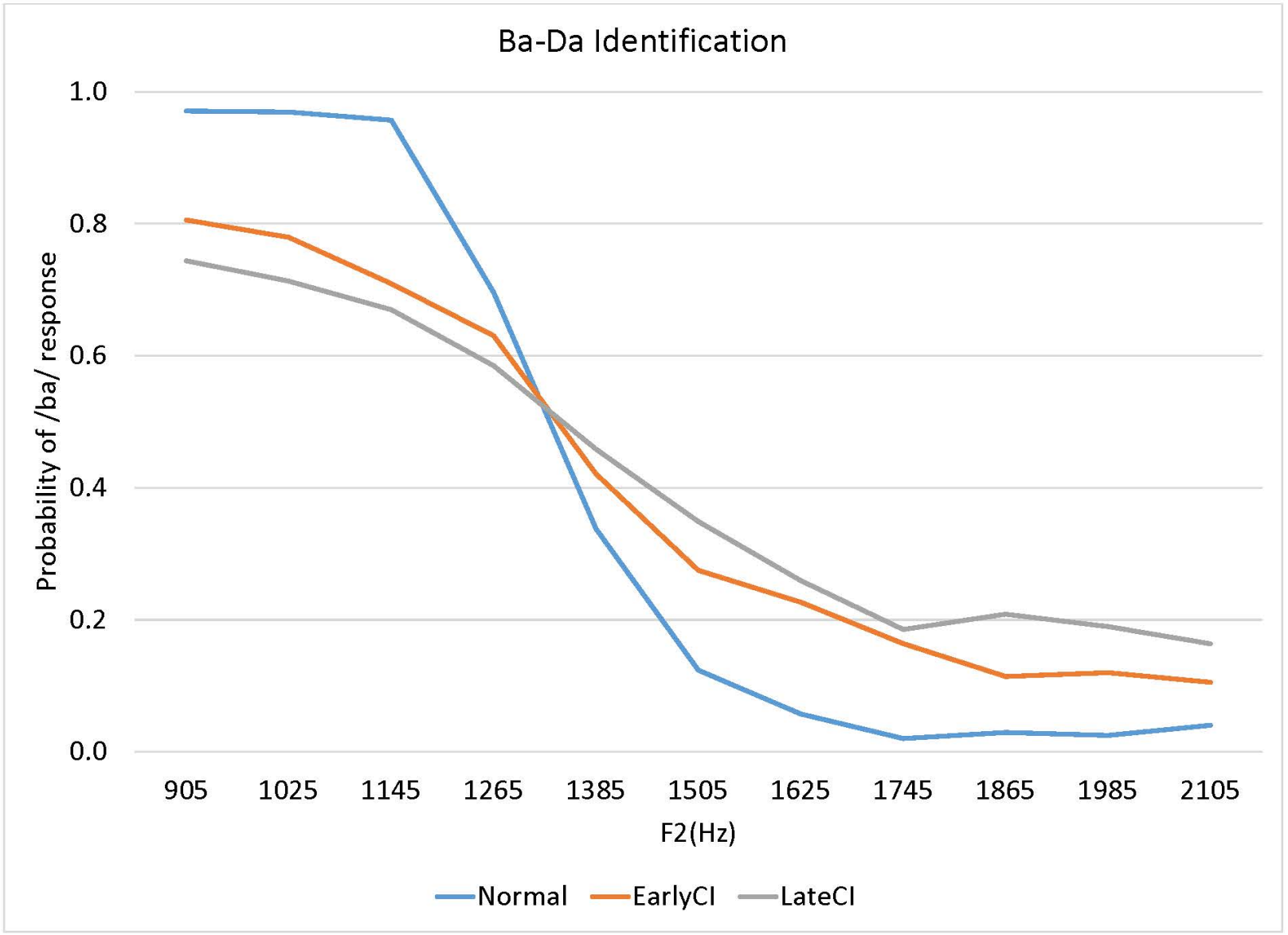
- Stimuli = synthesized speech
  - /b - p/ continuum – VOT
    - Voicing contrast
    - Initial stop consonant followed by vowel /a/
    - 11 stimuli with VOT ranging from -30 ms – 70 ms in steps of 10 ms
  - /b - d/ continuum – F2
    - Place contrast
    - Initial stop consonant followed by vowel /a/
    - 11 stimuli with F2 ranging from 905 Hz – 2105 Hz in steps of 120 Hz

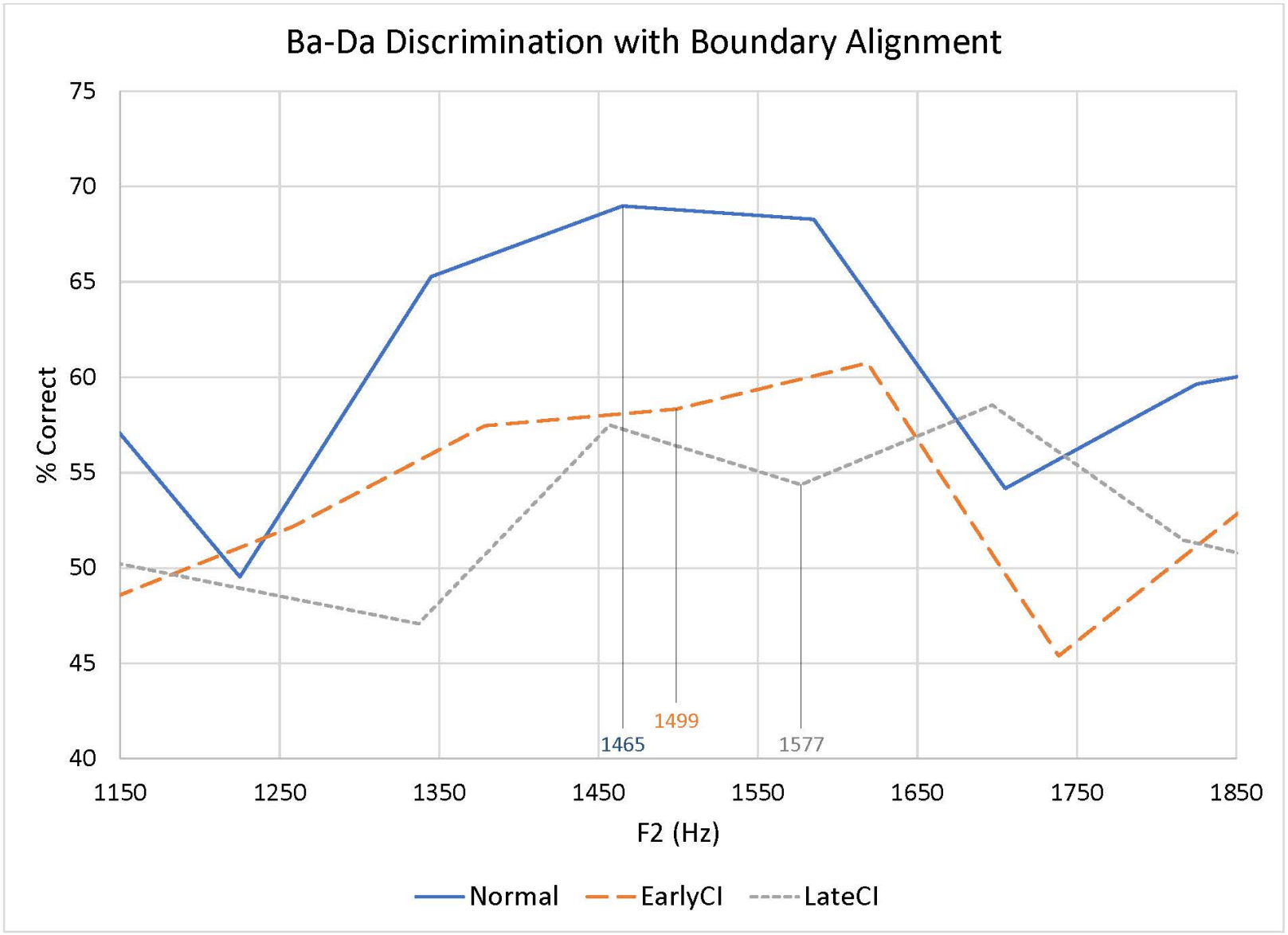
Hypotheses

- Early implant group will perform more like normal hearing controls on all tasks than the late implant group
- CI users' performance on the discrimination and identification of voicing cues (VOT) will more closely resemble the performance of the control group than their performance on place (F2 transition) cues.
- Considerable variation will be observed among the CI users


Ba-Pa Identification
1.0
0.8
0.6
0.4
0.2
0.0
Probability of /ba/ response
-30
-20
-10
0
10
20
30
40
50
60
70
VOT(ms)
Normal
EarlyCI
LateCI


Ba-Pa Discrimination with Boundary Alignment
% Correct
85
80
75
70
65
60
55
50
45
40
-20
-10
0
10
20
30
40
50
60
VOT (ms)
16.84
21.67
22.73
Normal
EarlyCI
LateCI


Ba-Da Identification
1.0
0.8
0.6
0.4
0.2
0.0
Probability of /ba/ response
905
1025
1145
1265
1385
1505
1625
1745
1865
1985
2105
F2(Hz)
Normal
EarlyCI
LateCI


Ba-Da Discrimination with Boundary Alignment
% Correct
75
70
65
60
55
50
45
40
1150
1250
1350
1450
1550
1650
1750
1850
F2 (Hz)
1465
1499
1577
Normal
EarlyCI
LateCI

Critical/Sensitive Periods

- Limited period of development in which environmental experience exerts a strong influence on behavior
- Observed in the development of sensory-perceptual, linguistic, social and other behaviors
- Reflect the development of underlying neural circuitry in the brain.

- Vocal learning in humans and certain species of animals depends upon environmental stimulation during species-specific developmental periods.
- Specific kinds of auditory experience are known to modify the learner's brain in ways that shape perception through the establishment of auditory categories.

- The development of phonetic categories entails
  - Learning to ignore allophonic (non-contrastive) variation
  - Establishing phoneme boundaries reflecting the structure of the native language
  - Not all phonemes are perceived categorically
    - Most consonants are perceived categorically
    - Vowels are perceived in a continuous fashion

Project Team

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