“Fantasy Language Conference”

Allophonic Variation and the Acquisition of Phoneme Categories

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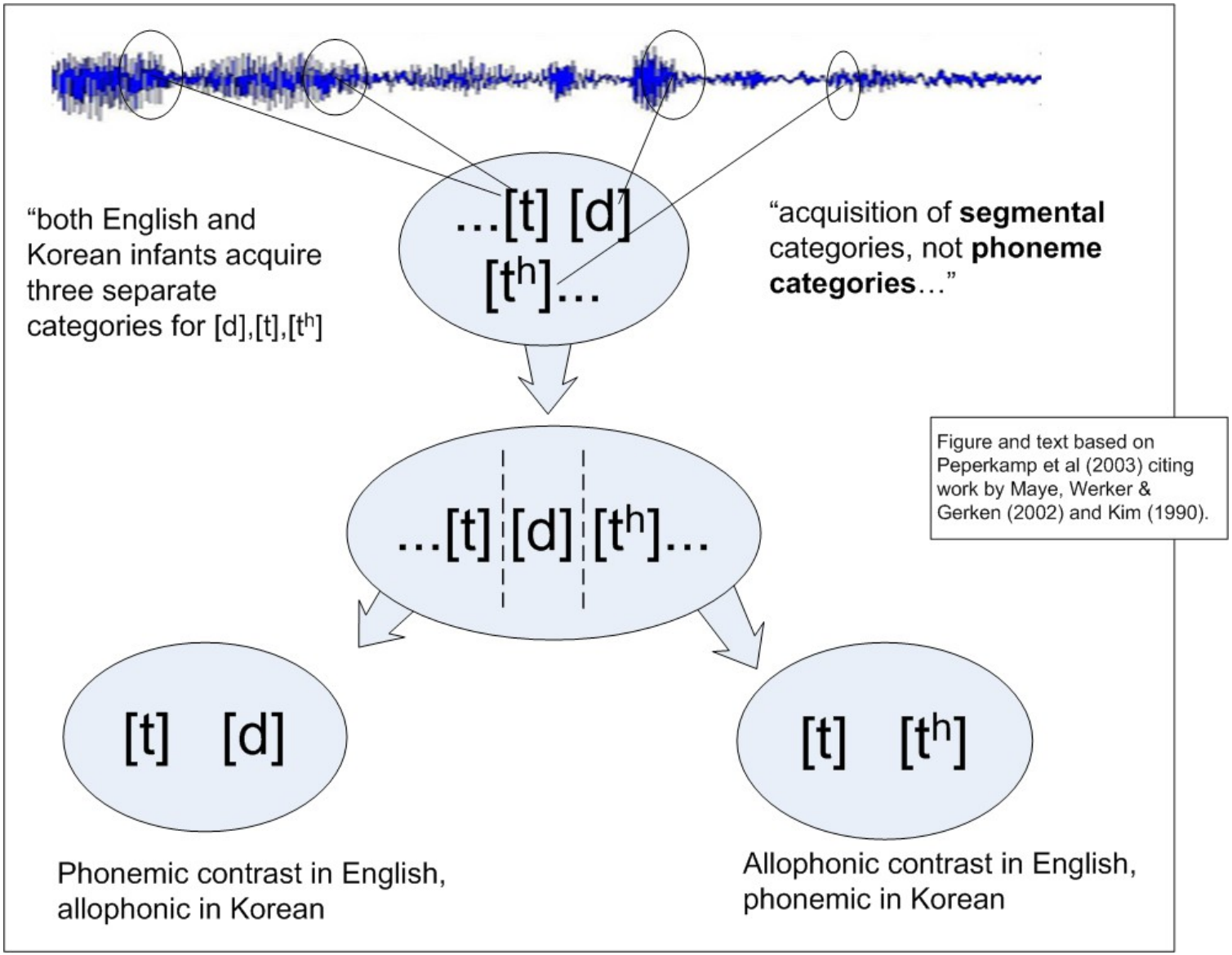
Overview

- Background to the Study
  - Theoretical Motivation
- Research Hypothesis
- Experiments
- Results and Analysis
- Conclusions and Next Steps
- Questions

Background

- Observations about language acquisition
  - First task of language acquisition:
    - Segment continuous signal into discrete categories that represent V and C
  - Infants distinguish allophones but not phonemes

Background (2)



Motivation

- Adults process allophonic and phonemic contrasts differently...
- We suspect that phonemes and allophones are learned on the basis of distribution analysis of stimuli
  - When do these distinctions begin to occur?

Methodology

- Develop an inventory of CV.VC sounds to use as stimuli with human subjects in...
- Two different discrimination-task experiments
  - Experiment 1: Perception of Phonemic versus Allophonic Contrasts
  - Experiment 2: Acquisition of Phoneme Categories
- Analyze outcomes
  - Determine what influence various factors may have on outcome

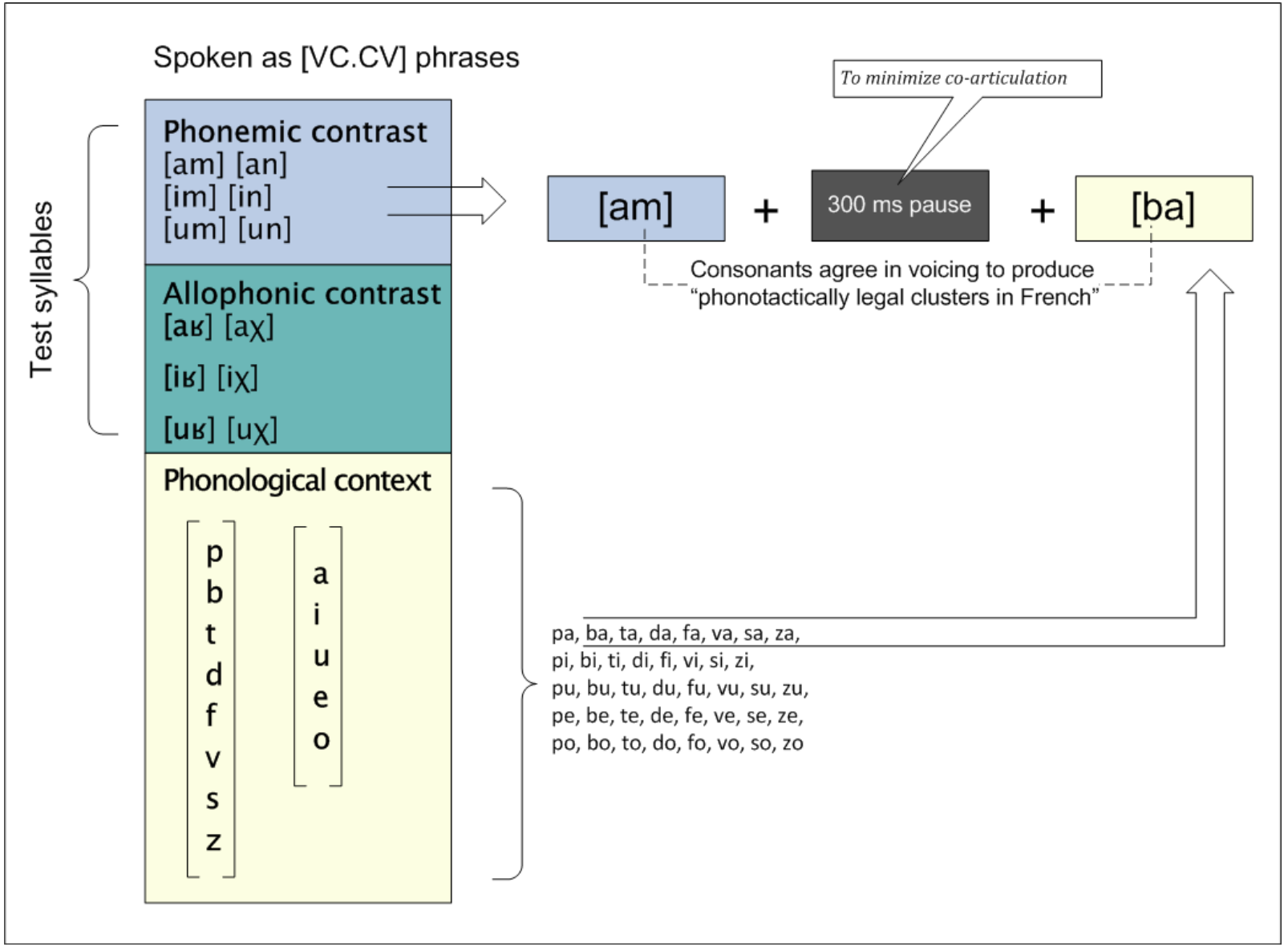
Creating the Stimuli

- Native French speaker (male)
- Allophonic contrast
  - [aχ] [aʁ] [iχ] [iʁ] [uχ] [uʁ]
    - [χ] is allophone of [ʁ]  
    - Environment is adjacent (either side) of voiceless Cs
- Phonemic contrast
  - [am] [an] [im] [in] [um] [un]
- Phonological context
  - 40 CV syllables made up of one each...
    - [p, b, t, d, f, v, s, z] + [a, i, u, e, o] = [pa], [pi]...

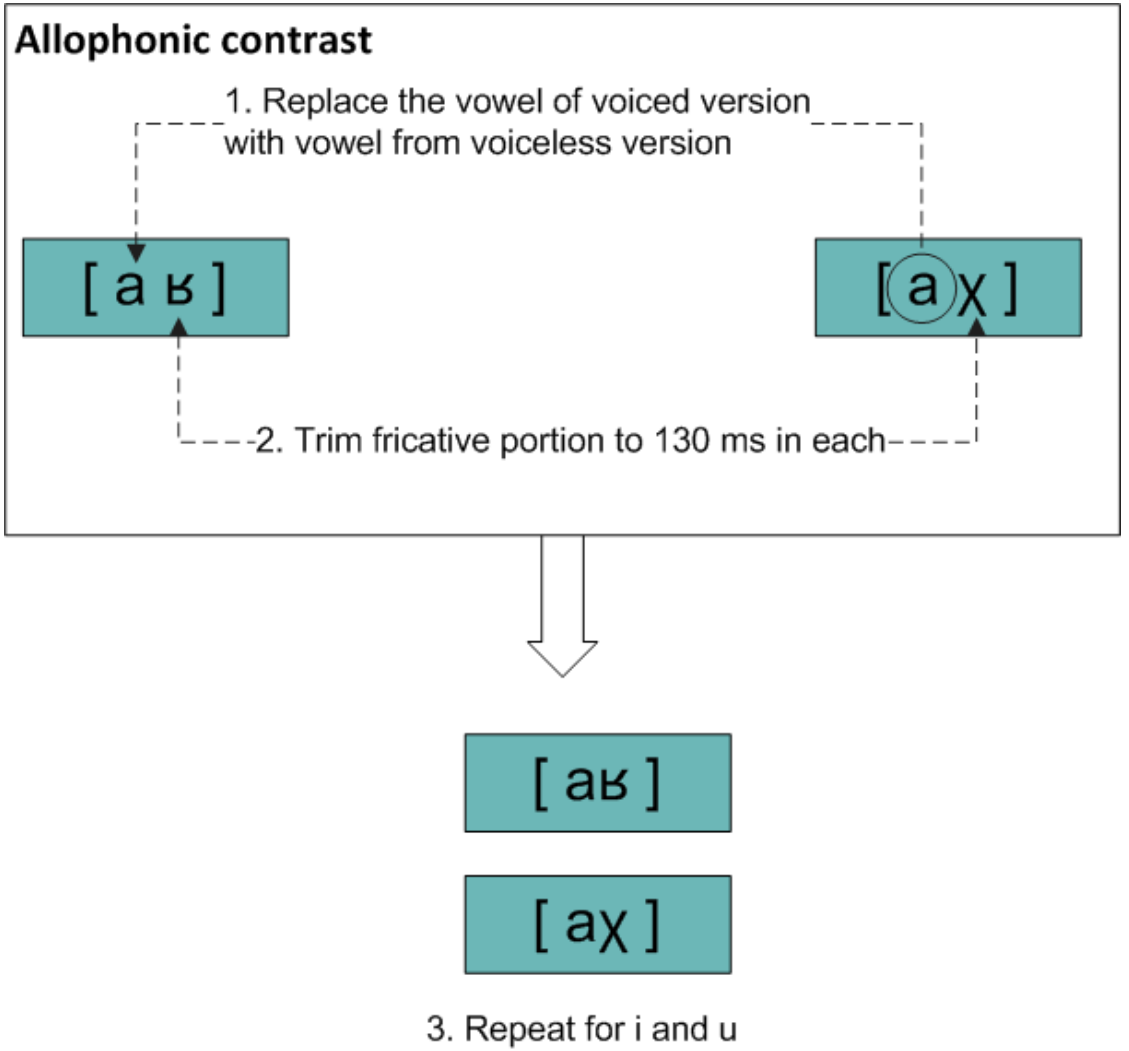
Creating the Stimuli: Overview

- Create test syllables from raw materials
  - Modify allophonic raw files to correct for vowel influence
  - Use phonemic raw files, 2 tokens each
  - Splice on phonological contrast raw sounds to all of the above to create disyllabic 'phrases'
- Result is an inventory of [CV] syllables that will presented to subjects in various combinations in each experiment

Creating the Stimuli (Recording)



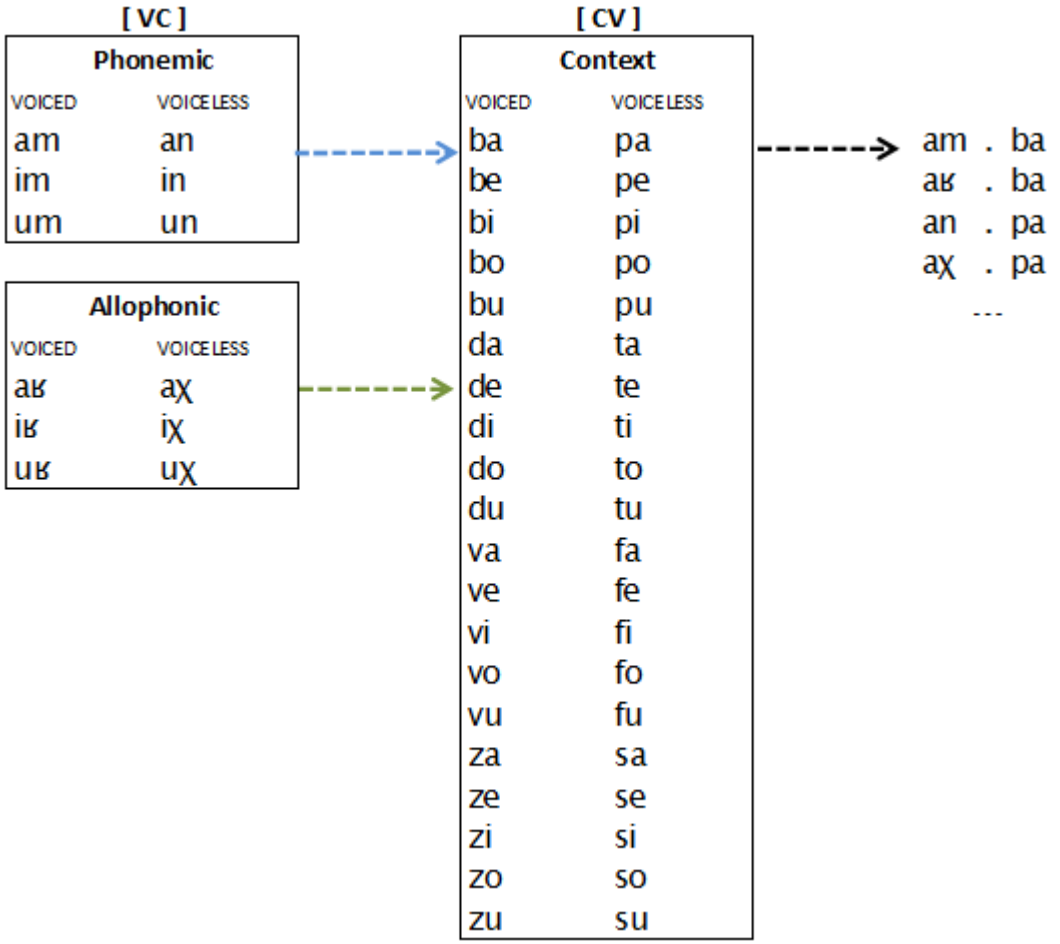
Creating the Stimuli



Modifying recorded VC sequences for allophonic-contrast tests

Creating the Stimuli: Inventory

- Syllables available to fabricate into [VC.CV]'s in many ways...



Experiment 1

- Perception of Phonemic / Allophonic Contrasts
- Looks at French speakers' ability to discriminate voiced uvular fricative [ʁ] from its voiceless allophone [χ]
  - In isolation
  - In context
- Process
  - Training
  - Test

Experiment 1: Training

- Subjects hear 5 pairs of two-word monosyllabic phrases that ‘veuf turc/veuf riche’ 
- Must identify as ‘same’ or ‘different’
- Feedback given to subjects

Experiment 1: Tests

- Test Subjects
  - 12 monolingual French native native speakers
- Isolation test:
  - Subjects told “you'll hear two monosyllabic foreign words”
  - Identify whether “same” or “different”
  - Trial presented as [Syl1] + [500ms] + [Syl2]
  - ...5000 ms pause, next trial...
  - 24 trials repeated 4 times, total 96 trials
  - 50% identical syllables, 50% different syllables

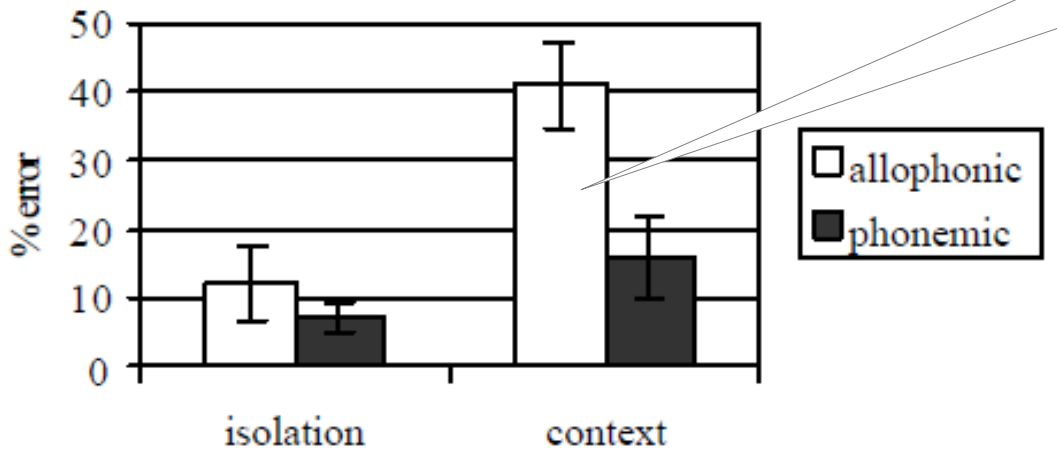
Experiment 1: Tests

- Phonological context
  - Subjects presented with [VC.CV] pairs
  - “You'll hear two short sentences made of two monosyllabic words in a foreign language...”
  - Indicate whether “same” or “different”
  - 96 trials
  - [Syl1] + [CtxSyl] + 500ms + [Syl2] + [CtxSyl2]
  - Context syllables ([CtxSyl]) chosen randomly
  - Allophonic Contrast vs. Phonemic Contrast

Experiment 1: Results

- French speakers easily identify [ʁ] vs [χ] in **isolation**
- But they don't do so well when allophonic contrasts are embedded within phonological context
- Confirms what we already know

Errors in allophonic discrimination in **context** rise to a high level compared to phonemic.



Experiment 2

- Acquisition of Phoneme Categories
- Hypothesis: Statistical learning relies on local prototype extraction mechanism **and** takes segment context into account

Experiment 2: Expectations

- Subjects exposed to stimuli in certain patterns create categories accordingly
  - Monomodal distribution pattern => single category
  - Bimodal distribution pattern => two categories
- Better discrimination with bimodal
- Assess bimodal bias w/other (voice) condition.

	Token statistics	Complementary distribution	Predictions
1	monomodal	no	1 category
2	bimodal	no	2 categories
3	bimodal	yes	1 category

Experiment 2

- Test Subjects
  - 60 monolingual French native native speakers in groups of 20 for type of exposure
- Process
  - Training
  - Pre-test
  - Exposure
  - Post-test

Experiment 2: Training

- Subjects hear 5 pairs of two-word monosyllabic phrases, eg., ‘veuf turc/veuf riche’
- Must identify as ‘same’ or ‘different’
- Feedback given to subjects

Experiment 2: Pre-test

- To assess capability to discriminate [ʁ-χ]
  - “You'll hear two short sentences made of two monosyllabic words in a foreign language...”
    - Indicate whether “same” or “different”
  - 48 trials; subjects hear [VC.CV] sequences
  - 50% of the trial sequences contained clusters in which both elements (VC and CV) agreed or disagreed in voicing.
  - 50% of the trial sequences contained one cluster in which both elements agreed (w/r/t voicing), and one cluster in which voicing did not agree.

Experiment 2: Exposure Patterns

- Sequences of stimuli presented in three different frequency distribution patterns
  - Monomodal
  - Bimodal
  - Bimodal + Assimilation groups

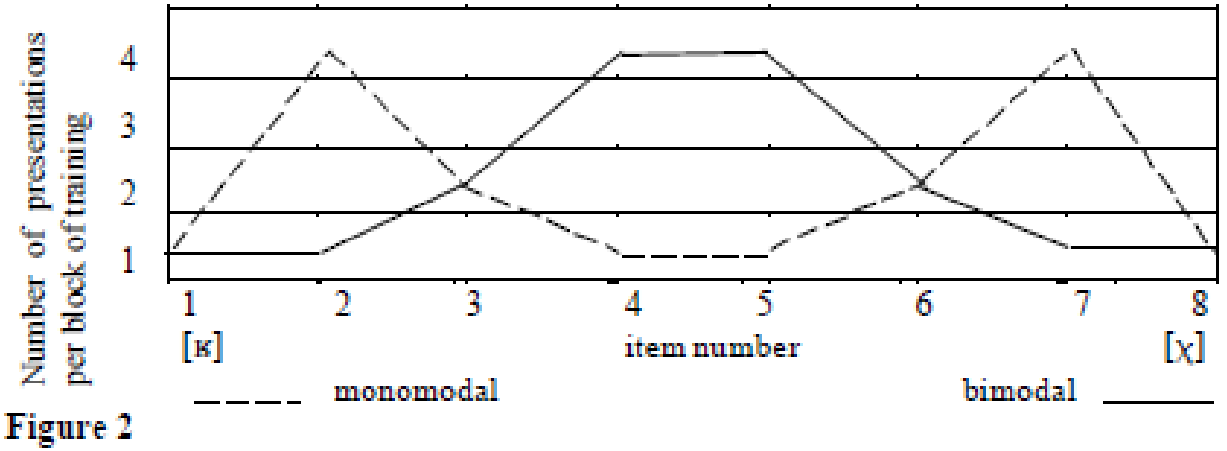
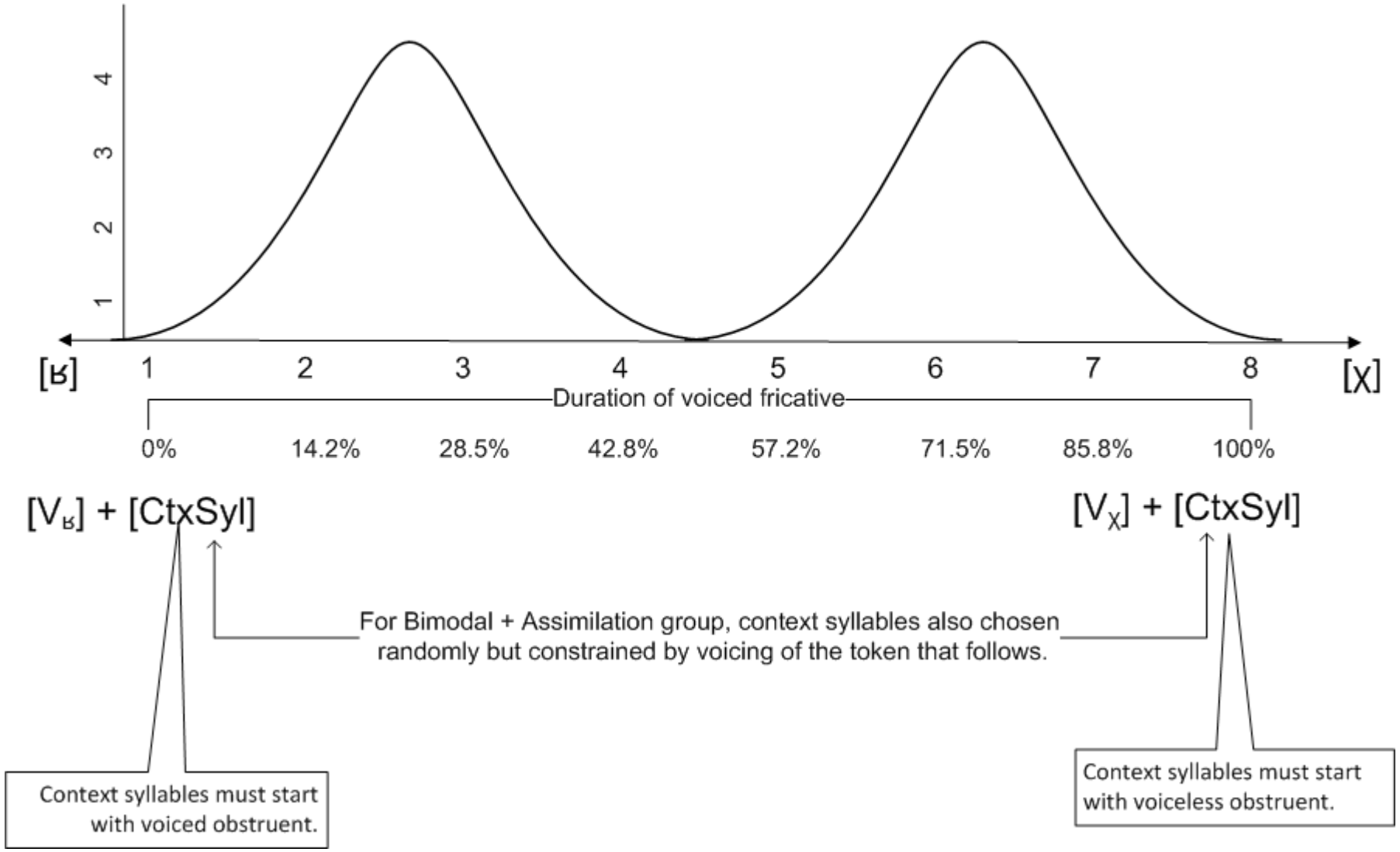


Figure 2

(Monomodal and bimodal mislabeled in fig 2.)

Experiment 2: Exposure (Group 3)

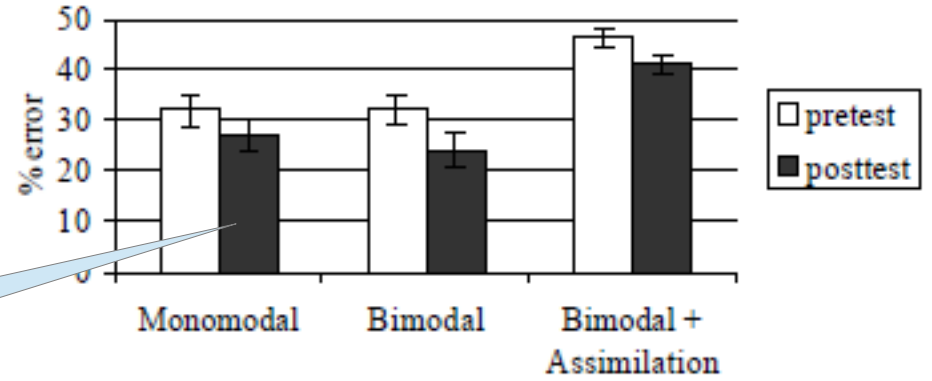


Experiment 2: Post-test

- Discrimination of [ʁ] and [χ] test again
- Same task and instructions as pre-test
- Same 48 trials
- Post-test results compared to pre-test to assess impact of “exposure”

Experiment 2 Results

- Small yet significant decrease in error rates in post-test compared to pre-test
- Bimodal group showed strongest amount of learning



Small but significant learning in monomodal is an **unexpected** surprise

Experiment 2 Results

- Results support our hypothesis that...
  - statistical learning relies on local prototype extraction mechanism **and** takes segment's context into account as well.
- Context important
- Sensitive to complementary distribution
  - Due to Bimodal + Assimilation = significantly more errors in pretest than Monomodal and Bimodal.

Conclusions

- Experiment 1: Allophonic contrast in isolation readily identified by listeners; not so in context.
- Experiment 2: Provides evidence that statistical/ phonological token distribution affects learning.
- Next Steps:
  - Increase power of training procedure.
  - Test infants with training procedure and see if they acquire phoneme categories due to distribution.

Discussion and Questions

- List of references and background information in your hand-outs
- Merci!