Nasal codas in Chinese and English

– a study in the framework of
the distinctive feature theory

24.921 Class Presentation

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Purpose

- Better understand the acoustic correlates of nasal codas in English and Standard Chinese (SC), within the framework of the distinctive feature theory

- Eventually compare with acoustic correlates of syllable-initial nasals to develop an algorithm to classify the nasal consonant place of articulation

- Incorporate algorithm into a distinctive feature-based speech recognition system

Background
(Stevens, 1989)

- The quantal nature of speech
  - a critical factor in shaping the inventory of phonological features used to signal distinctions in language
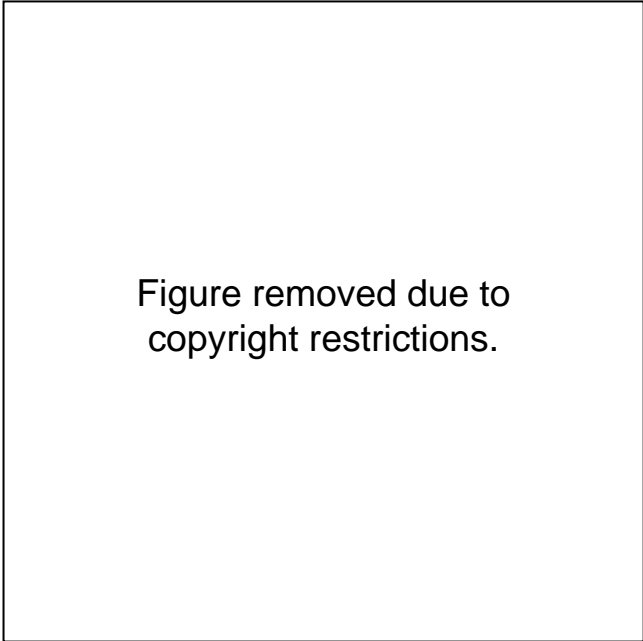 - a basis for the distinctive feature theory

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Background Cont.

Feature values for nasal consonants in English

Feature	m	n	■ ŋ
Vocalic	-	-	-
Consonantal	+	+	+
Continuant	-	-	-
Sonorant	+	+	+
Lips	+		
Tongue blade		+	
Tongue body			+
Anterior		+	
High			+
Back			+
Nasal	+	+	+

Motivation

- Enhancing gestures
  - enhance the perceptual contrast defined by the distinctive feature
  - may be language dependent because the inventory of features and contrasts is language-dependent

- SC - official language of China, based on the Beijing dialect
  - the only possible coda is the nasal
  - no competition for perceptual contrast
  - enhancing gestures may be different

- Examine differences in nasal codas in English and SC
  - real-time online adaptation experiment

Experimental background

Allophonic distributions of the underlying low vowel /A/ followed by a nasal in SC

	Vowel /A/	
Lexical representation	/ [+low] n /	/ [+ low] ŋ /
Assimilation	[-back] n [+low]	[+back] ŋ [+low]
Surface form	[an]	[ɑŋ]

Experimental design

Possible mappings:

English words	SC loan adaptations
bæn	pan
	pɑɪŋ
bɑn	pan
	pɑɪŋ
bæŋ	pan
	pɑɪŋ
bɑɪŋ	pan
	pɑɪŋ

4 possibilities in English

2 possibilities in SC

Hypotheses

Hypothesis A:
Mapping occurring at
the phonemic level

English	SC
æn	an
ɑn	an
æɪ	ɑɪ
ɑɪ	ɑɪ

Hypothesis B:
Mapping occurring at
the phonetic level

English	Standard Chinese
æn	an
ɑn	ɑɪ
æɪ	an
ɑɪ	ɑɪ

Experimental setup

- Stimuli
  - 36 nonsense English utterances and 36 fillers by a native speaker of English
  - 36 Chinese words and 36 fillers by a speaker of SC.

- Presentation of stimuli
  - each stimuli was presented acoustically to the subjects in the AXB frame, where AB=SC, X=English

- Subjects
  - 15 native speakers of SC
  - decide which SC stimulus sounded the closest to the English stimulus

Results

English	SC adaptations	
æn	an	88.2%
	ɑŋ	11.8%
ɑn	an	50.9%
	ɑŋ	49.1%
æŋ	an	71.1%
	ɑŋ	28.9%
ɑŋ	an	19.6%
	ɑŋ	80.4%

Mappings

English		Standard Chinese
[æn]	→	[an]
[ɑŋ]	→	[ɑŋ]
[æŋ]	→	[an]
[ɑn]	→	either [an] or [ɑŋ]

Exploration of results

(Let A represent the backed /A/, a the fronted /A/)

- Questions raised
  1. Why is the English [aeng] mapped to the SC [an]?
  2. Why is the English [An] mapped to *either [an] or [Ang]* in SC (i.e. 50/50 split)?

- Possible explanations
  - Perhaps "vowel quality" is more important in on-line adaptations
  - Nasal codas in English and SC have similar acoustic attributes but the attributes differ in weighting due to differences in phonotactic constraints

Acoustic theory of nasalization

- Nasal consonants
  - complete oral closure
  - open velopharyngeal port
  - no pressure increase behind the constriction

- Nasal branch
  - adds extra poles and zeros to the all-pole system of the oral vowel
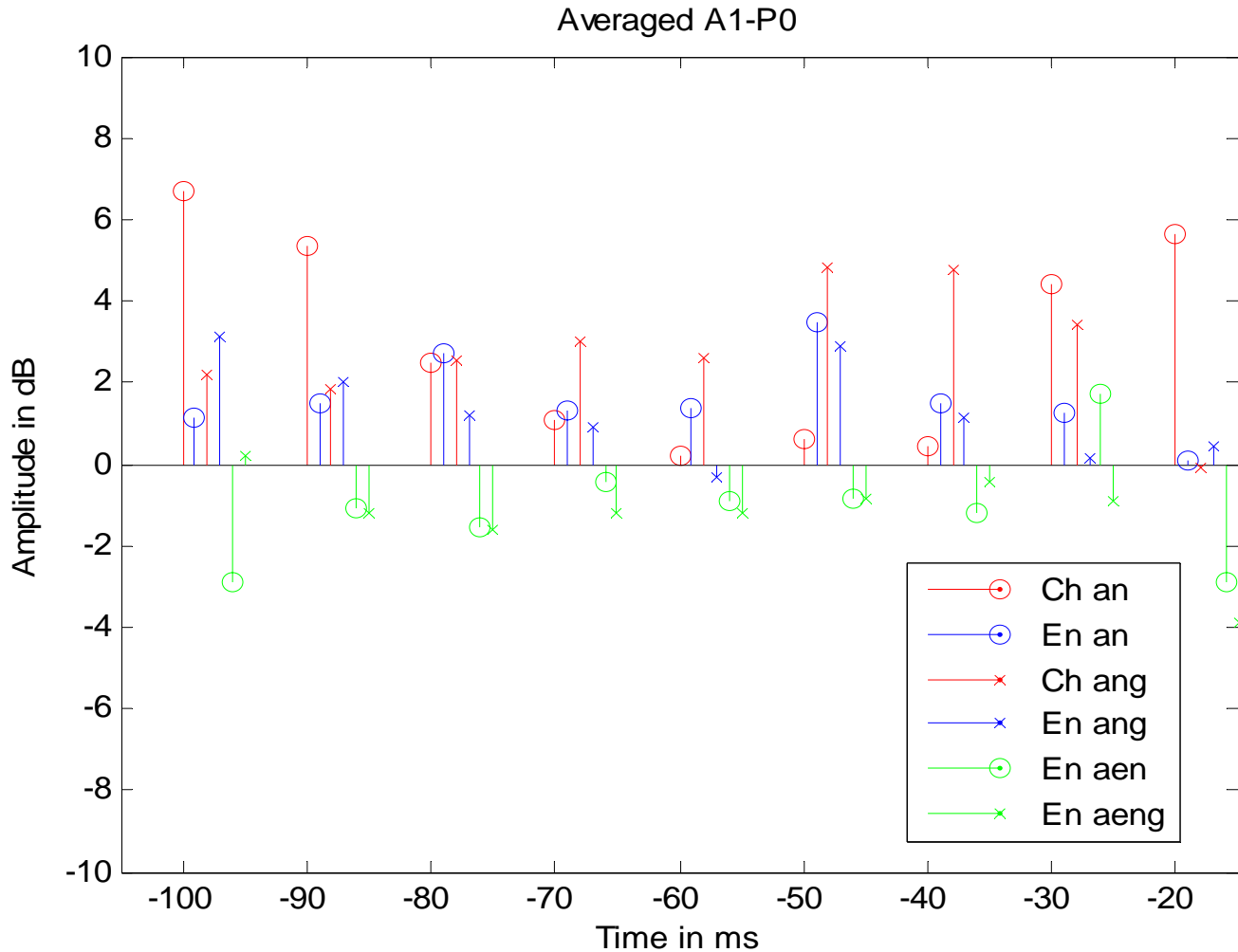
Acoustic evidence

F2 transition

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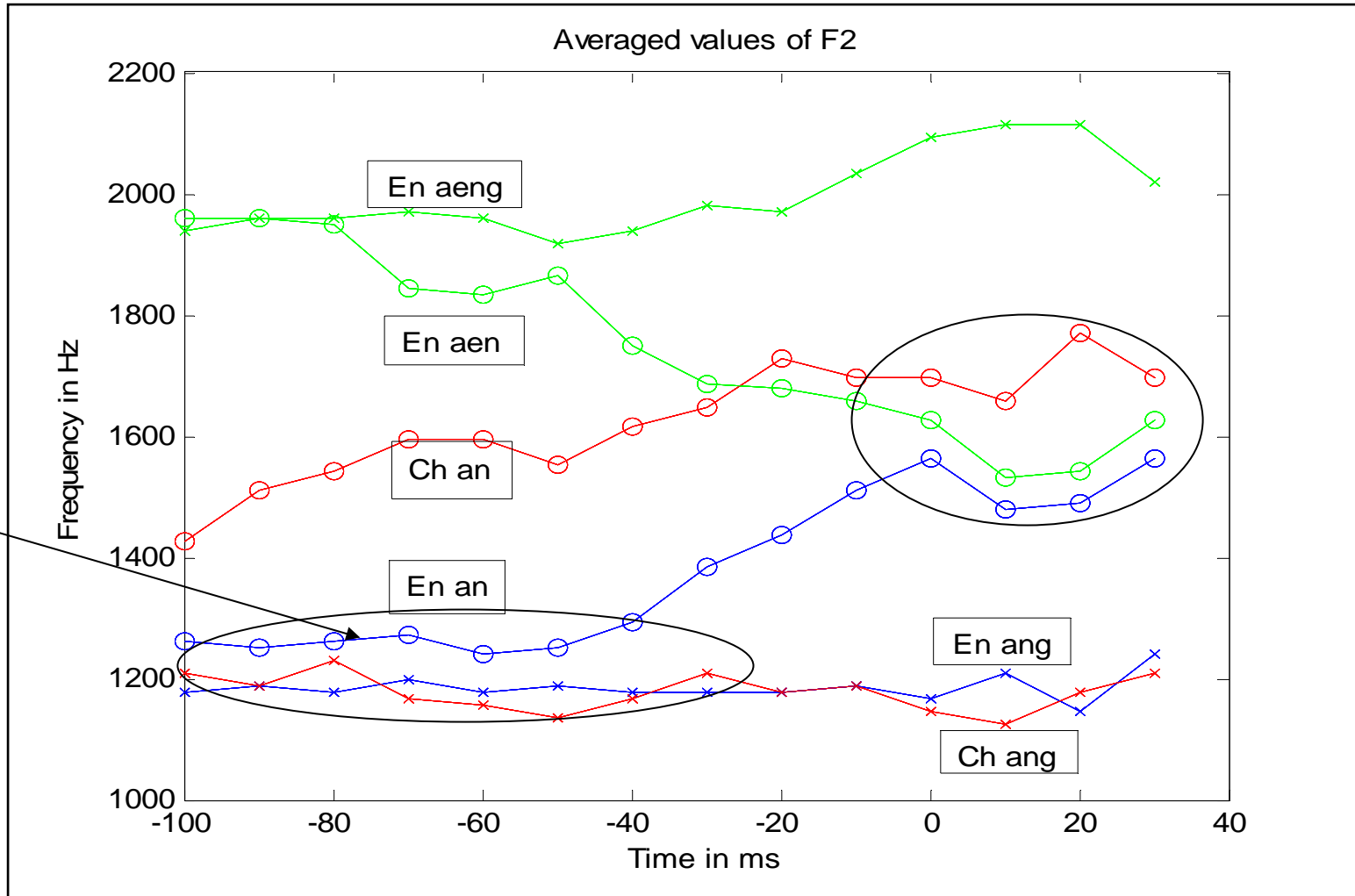
Summary

Mappings

English		Standard Chinese
[æn]	→	[an]
[ɑŋ]	→	[ɑŋ]
[æŋ]	→	[an]
[ɑn]	→	either [an] or [ɑŋ]

English	SC	Vowel	Consonant
æn	an	✓	✓
æŋ	an	✓	×
ɑn	an/ɑŋ	✓(ɑŋ)	✓(an)
ɑŋ	ɑŋ	✓	✓

Acoustic evidence cont.:
Average values of A1-P0

Averaged A1-P0

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Thank you!

Questions and comments?

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