

# **Evidence for plasticity in studies examining second language speech acquisition**

**James E. Flege**

*Univ. of Alabama at Birmingham*

ISCA Workshop on Plasticity  
in Speech Perception  
15-17 June 2005, London, UK

# Outline

1. Arguments for a loss of plasticity
2. Counter arguments
3. Factors affecting L2 speech perception & production
4. Access to the properties of L2 speech sounds
5. Plasticity

# Outline

1. **Arguments for a loss of plasticity**
2. Counter arguments
3. Factors affecting L2 speech perception & production
4. Access to the properties of L2 speech sounds
5. Plasticity

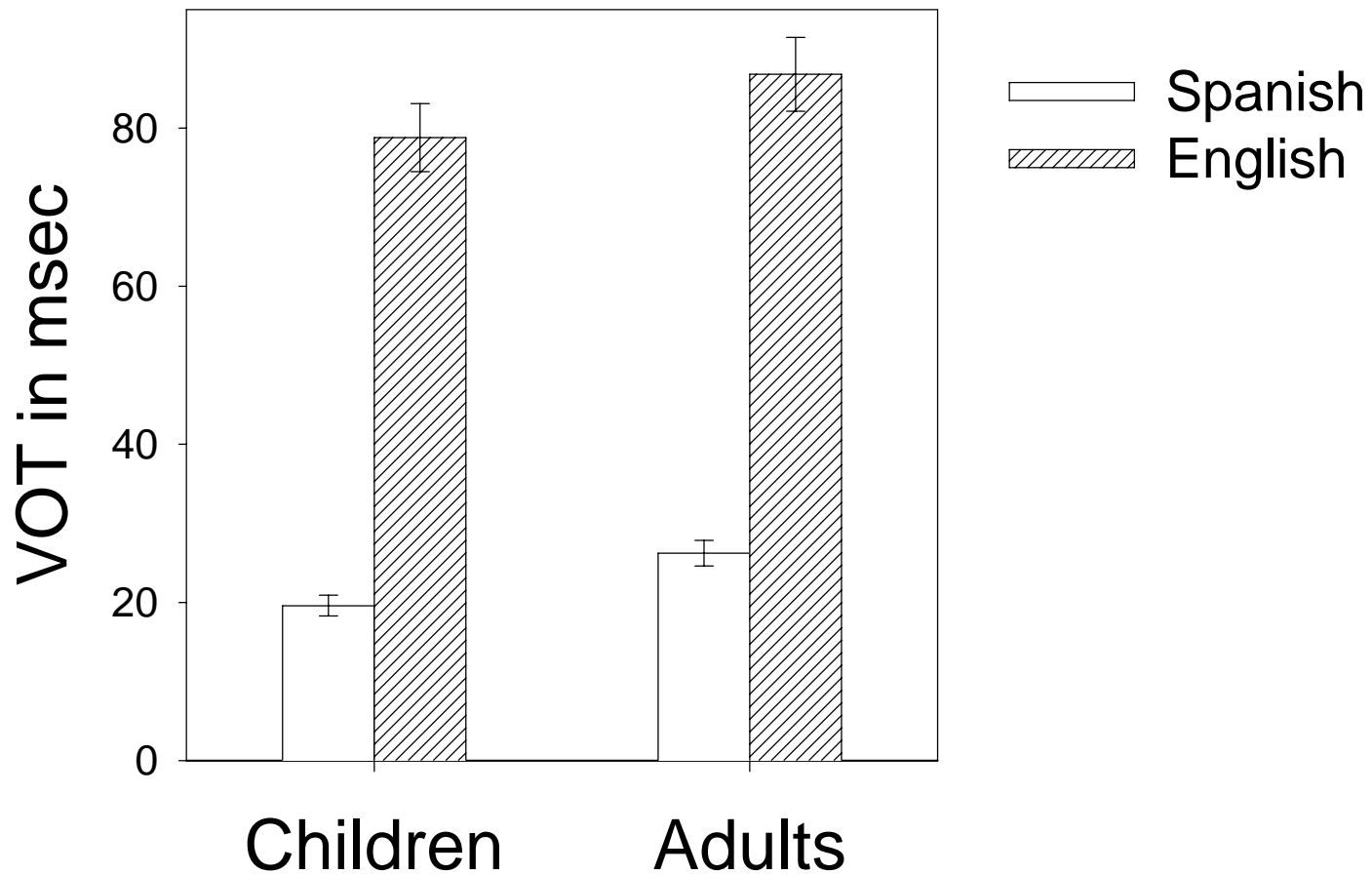
# Lost plasticity?

## **Background**

- 1) During infancy and childhood, perceptual “attunement” occurs
- 2) Infants/children establish perceptual representations based on what they hear/see
- 3) Guide production (“alignment”)

# Flege and Eefting (1987)

## VOT in word-initial /p t k/



# Lost plasticity?

## **Background**

- 4) The phonetic/phonological systems of languages differ (number of categories, phonetic detail)
- 5) Most phonetic segments encountered by an L2 learner will differ phonetically from closest L2 phonetic segment

# Lost plasticity?

## Background

5) Size of L1-L2 phonetic differences vary

- No difference, or too small to detect auditorily (“identical”)
- somewhat larger (“similar”)
- substantial (“new” ... L2 sound has no obvious phonetic “counterpart” in L1)

# Lost plasticity?

## Background

- 6) Despite L1-L2 phonetic differences, L2 sounds usually heard as instances of previously established L1 category in early stages of L2 learning

# Lost plasticity?

## Background

- Example 1: Spanish speakers hear realizations of English /t/ as instances of Spanish /t/ despite VOT differences (short-lag [t] in Spanish, long-lag [t<sup>h</sup>] in English)

# Lost plasticity?

## Background

- Example 2: Instances of both English liquids (/r/, /l/) heard as instances of single Japanese liquid (/R/)

# Lost plasticity?

Observations like these consistent with two notions

1. L2 phonemes are heard through the “phonological grid” of the L1)  
(Trubetzkoy)
2. Within-category phonetic differences tend to be ignored  
(categorical perception)

# Lost plasticity?

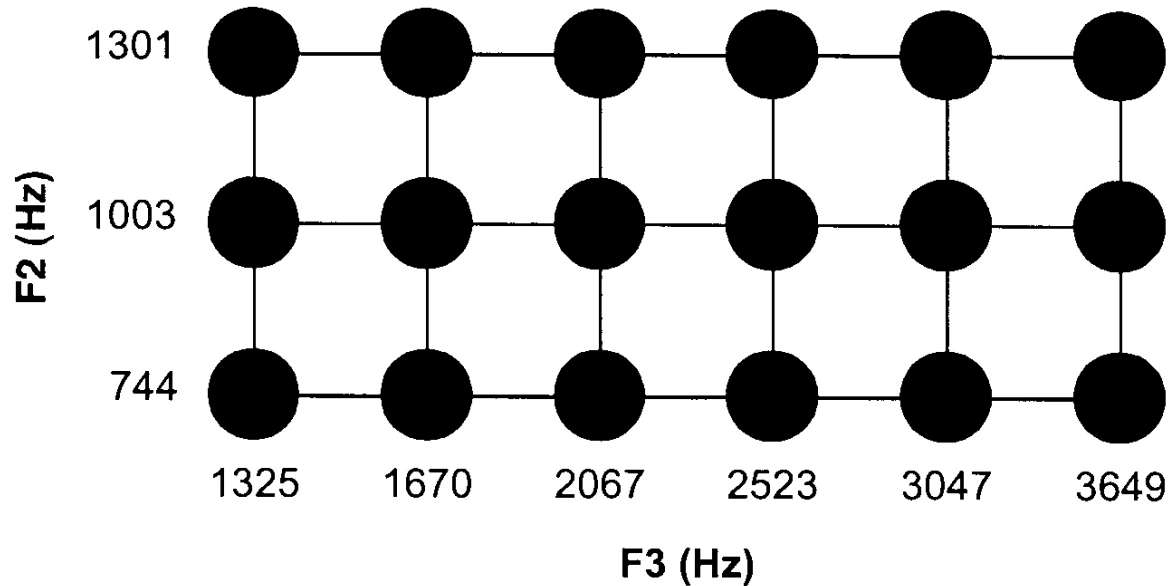
Lead to expectations:

1. Phonological features needed to distinguish L2 phonemes “filtered out” if not needed to distinguish L1 phonemes
2. Phonetic features/properties that distinguish L1 from L2 sounds may also be filtered out

# Lost plasticity?

- Word-initial English liquids /r/ and /l/ notoriously difficult for Japanese adults to differentially identify
- May be due to
  - Failure to use a feature/property needed to distinguish English /r/-/l/
  - Continued use of inappropriate L1 feature/property
  - Both

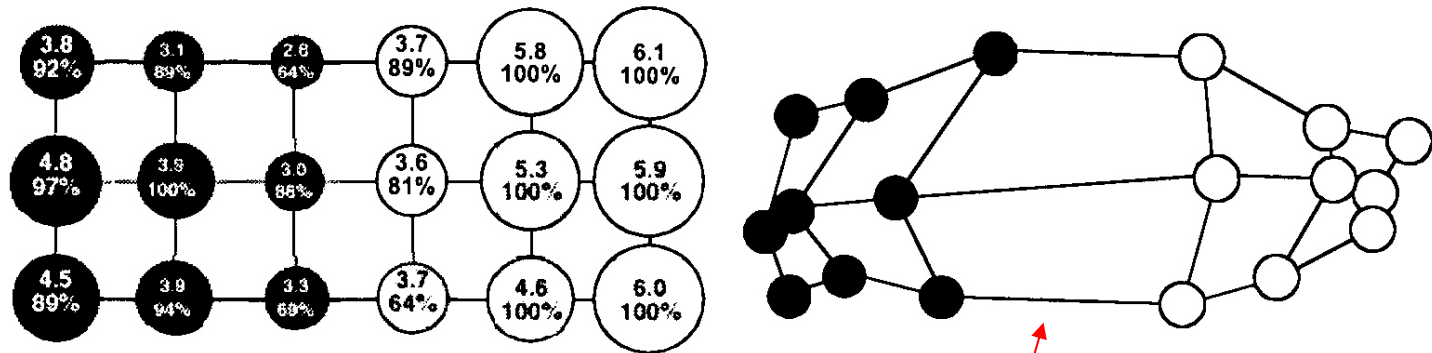
# Iverson et al. (2003)



*Figure 1: Formant frequencies for the English /ra/ and /la/ stimuli used in this study (from Iverson & Kuhl, 1996). The stimuli varied in terms of the second (F2) and third (F3) formants during the initial consonant. The formant frequencies were spaced equally using the Mel scale (a perceptual scale based on the mapping between frequency and pitch).*

# Iverson et al. (2003) MDS solution for native English listeners

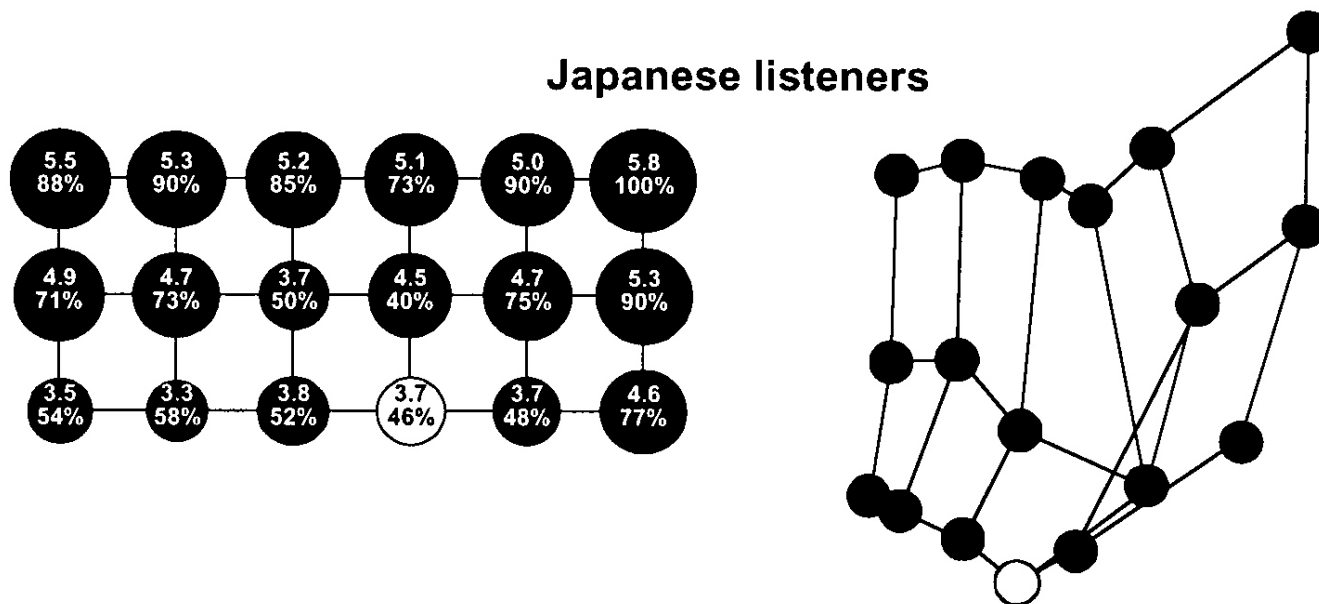
American listeners (Iverson & Kuhl, 1996)



Stretching of F3 at /r/-/l/ category boundary

Iverson et al. (2003)

MDS solution for native Japanese listeners



*insufficient use of F3 to distinguish /r/-/l/  
Too much use of F2*

# Lost plasticity?

If L1-L2 differences are filtered out, then:

1. Accurate representations not developed for L2 sounds
2. L2 sounds may not be produced accurately (assuming that perceptual representations continue to guide articulatory learning, as in L1)

# Lost plasticity?

Another reasons to assume that the plasticity needed for L2 speech learning is lost:

Widespread acceptance of that a critical period exists for L2 speech learning

# Lost plasticity?

- **Lenneberg (1969)** proposed a critical period for L1 acquisition
- extended to L2 because of the observation that most people learning an L2 after the age of 12 speak the L2 with foreign accent

# Lost plasticity?

According to Scovel (2000, pp. 200-213) the critical period hypothesis (CPH) for L2 learning has

- *Arise from normal neural development*
- *“Inherent fascination”*
- *Is accepted by most researchers in some form*

# Lost plasticity?

Problems with the CPH for L2 speech learning

- Doesn't identify which specific aspect(s) of speech learning affected
- Doesn't directly link deficits to specific brain mechanisms/functions

# Outline

1. The “Doom” (no plasticity) hypothesis
2. **Counter arguments**
3. Factors affecting L2 speech perception & production
4. Access to the properties of L2 speech sounds
5. Plasticity

# Counter arguments

## **Hypothesis of the Speech Learning Model (Flege, 1995, 1999, 2002, 2003)**

The processes and mechanisms that guide successful L1 speech acquisition—including the ability to establish new phonetic categories—remain intact across the life span

# Counter arguments

## **SLM hypothesis**

Adults & children can -- eventually -- gain perceptual access to properties needed to differentiate L2 speech sounds (meaning), and L1-L2 speech sounds, even if such properties not needed to differentiate L1 speech sounds

# Counter arguments

## **SLM hypothesis**

Adults & children can -- eventually -- gain perceptual access to properties needed to differentiate L2 speech sounds (meaning), and L1-L2 speech sounds, even if such properties not needed to differentiate L1 speech sounds **“Full Access Hypothesis”**

# The Full Access Hypothesis

Motivation from

- Cross-dialect research
- Research with bilinguals hearing foreign-accented L2
- Research with monolinguals hearing foreign-accented speech

# The Full Access Hypothesis

## **Cross-dialect evidence**

- Adults readily detect small within-category phonetic difference between dialects
- Source of many jokes (imitations)
- Evidence that adults can detect and store information pertaining to cross-dialect phonetic differences

# The Full Access Hypothesis

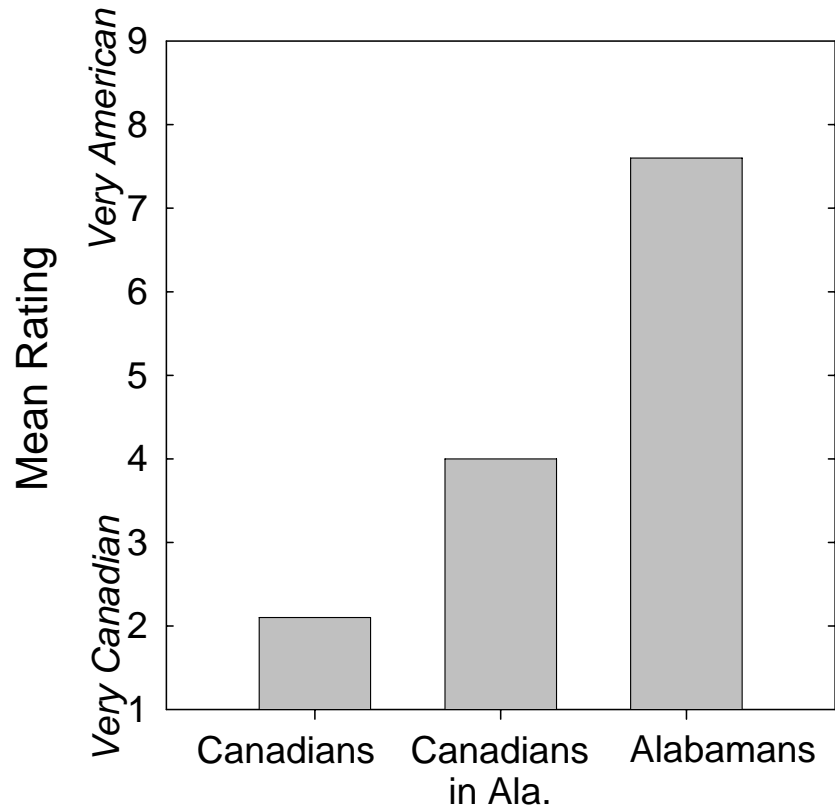
- Empirical evidence from [Munro, Derwing & Flege \(1999\)](#)
- Recorded three groups of adult native speakers of English
  - Residents of Edmonton, Alberta (Canada)
  - Residents of Birmingham, Alabama (USA)
  - Canadians living in Alabama (USA)

## Munro et al. Flege (1999)

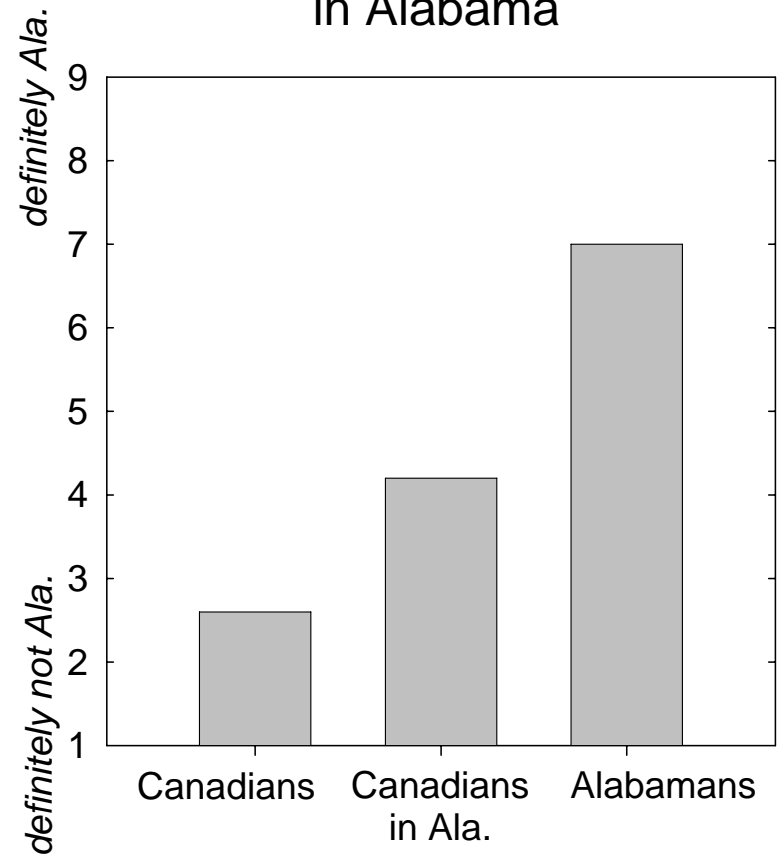
- Speech samples rated by adult listeners in
  - Birmingham (USA)
  - Edmonton (Canada)

# Munro et al. (1999)

## Canadian Listeners in Canada



## American Listeners in Alabama



# The Full Access Hypothesis

## **Bilinguals hearing foreign-accented L2 speech**

- Adults who speak their L2 with a strong foreign accent can perceive foreign accent in L2 sentence spoken by other nonnative speakers

# The Full Access Hypothesis

## **Bilinguals hearing foreign-accented L2 speech**

- MackKay, Flege, & Imai (in press) obtained ratings of English sentences spoken by Italian-English bilinguals from two listener groups
  - Native English
  - Native Arabic

# The Full Access Hypothesis

## **Bilinguals hearing foreign-accented L2 speech**

- Ratings from native English, Arabic adults strongly correlated ( $r = .94, p < .01$ ) even though Arabs spoke English with strong foreign accents

# The Full Access Hypothesis

## **Bilinguals hearing foreign-accented L2 speech**

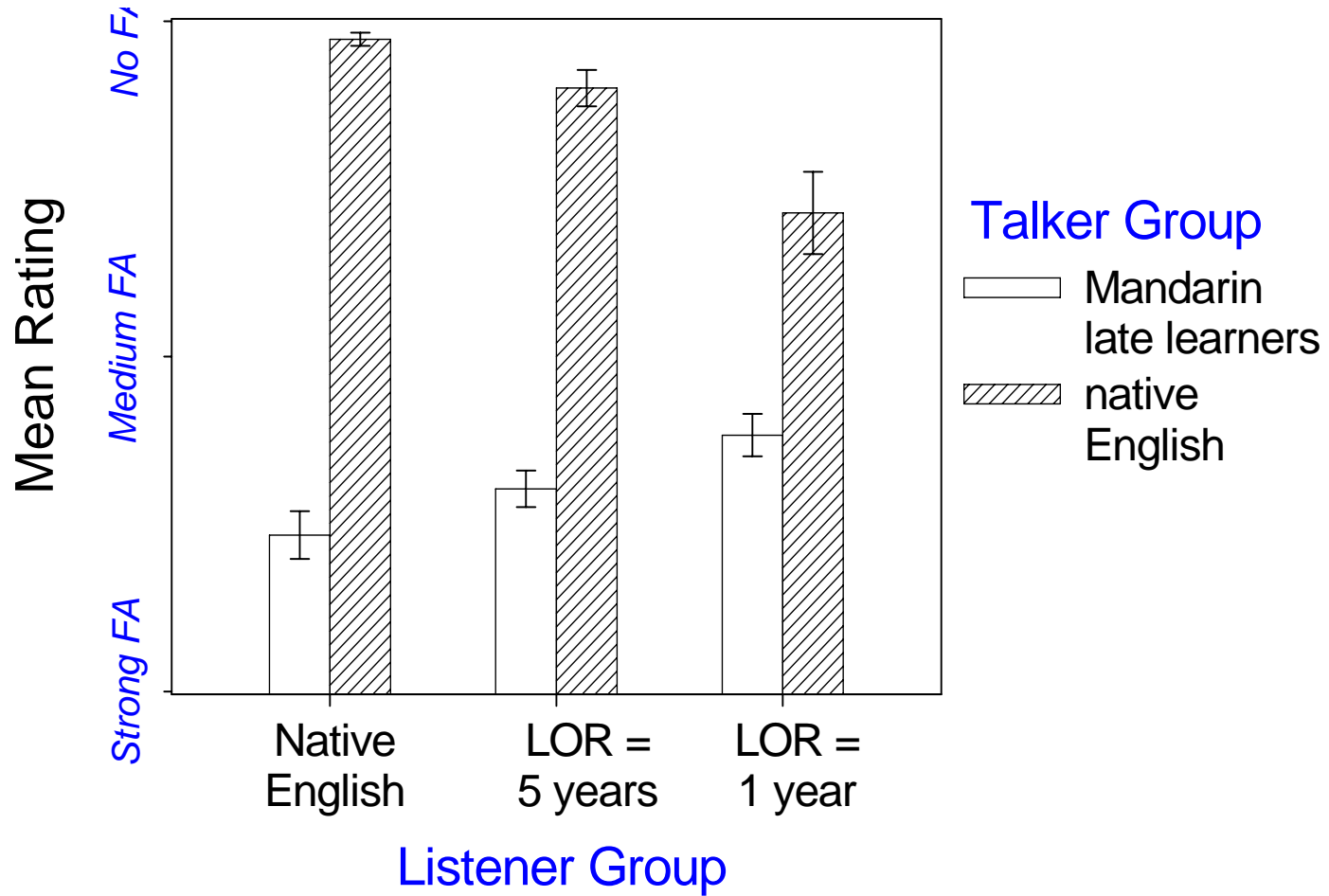
- Ratings from native English, Arabic adults strongly correlated ( $r = .94, p < .01$ ) even though Arabs spoke English with strong foreign accents
- **What about nonnative adults hearing their own kind of foreign accent?**

# The Full Access Hypothesis

## **Bilinguals hearing foreign-accented L2 speech**

- Flege (1988) examined English sentences produced by native speakers of English and Chinese
- Rated by three listener groups:
  - Native English*
  - Native Chinese, LOR = 1 year*
  - Native Chinese, LOR = 5 years*

# Flege (1988)



# The Full Access Hypothesis

## **Monolinguals hearing foreign-accented speech**

Flege & Hammond (1982)

**Aim:** determine if monolingual English adults can detect and store phonetic differences due to L1-L2 phonetic differences thru exposure to Spanish-accented English

## Flege & Hammond (1982)

- Tested 50 native English college students
- Enrolled in 1<sup>st</sup> year Spanish classes at University of Florida
- Classes taught in English by Spanish-accented teachers

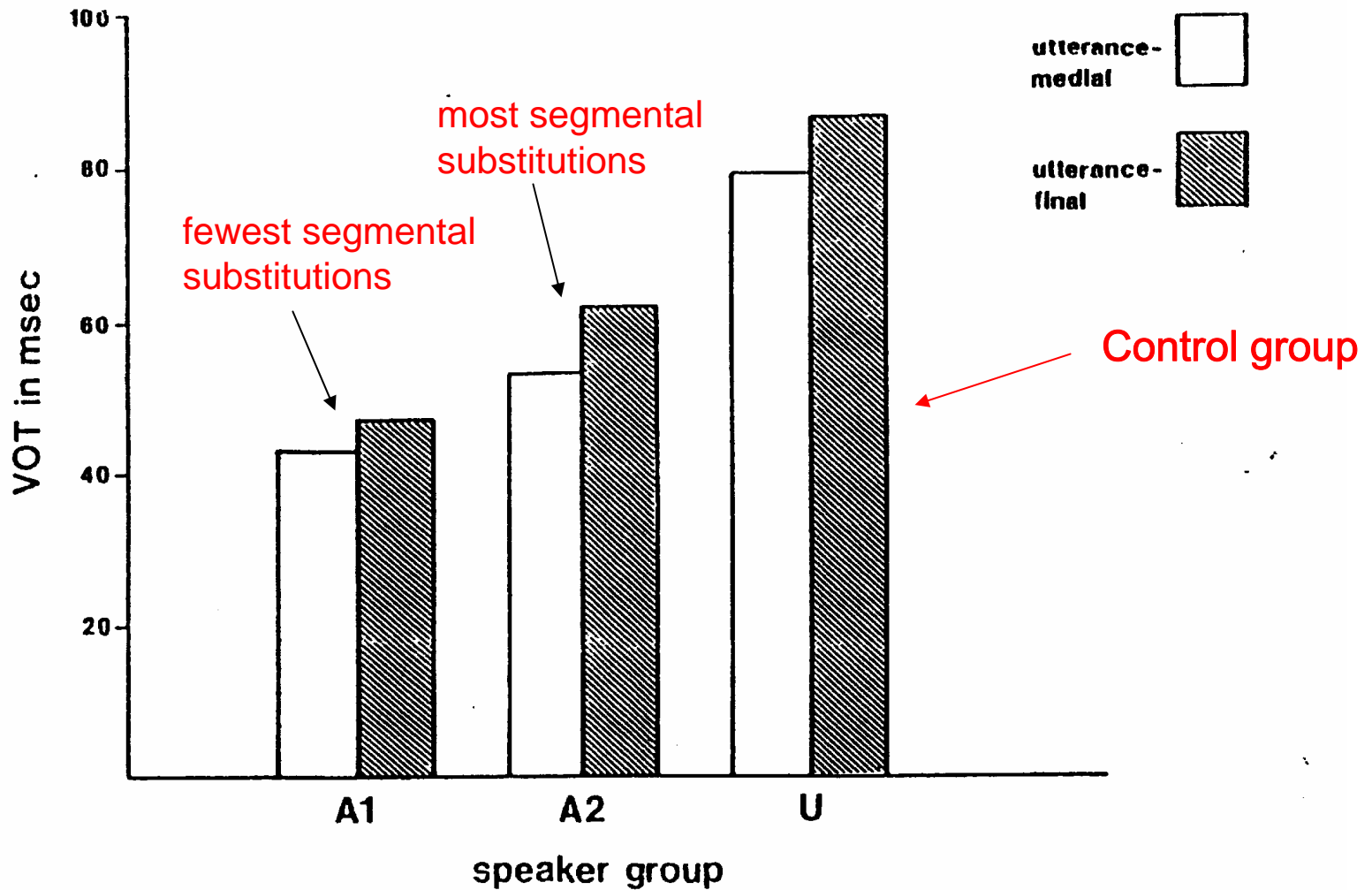
**Task:** Try to produce English words inserted into a carrier phrase (*The\_\_is on the\_\_*) with a “Spanish accent”

Lexical Items	Substitute	Frequency
nose, cheese, hose	s/z	141 (47%)
vice, veil, vase	b/v	129 (43%)
fig, pig, wig	i/I	127 (42%)
book, hook, crook	u/U	61 (20%)
shell, sheet, sheep	č/š	49 (16%)
bean, phone, bone	ŋ/n	1 (0.3%)
tape,tube, toad	d/t	0 (0.0%)

## Flege & Hammond (1982)

- In Spanish-accented English, /t/ often produced with VOT midway between values typical for Spanish & English
- The students did substitute /t/ for /d/ when imitating Spanish accent
- Failed to detect VOT shortening in Spanish-accented /t/?

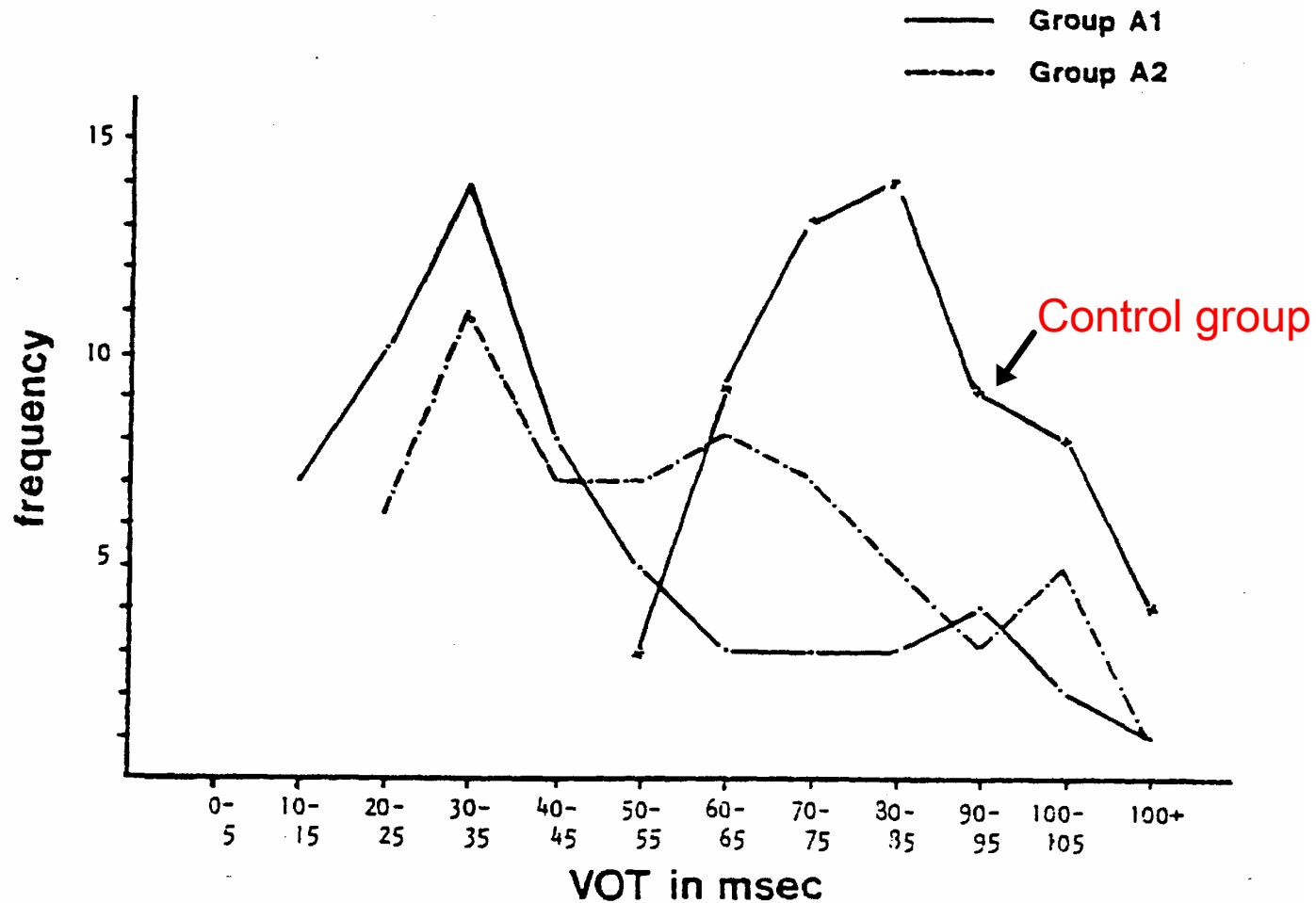
# Flege & Hammond (1982)



# Flege & Hammond (1982)

- VOT finding not an artifact of combining Spanish short-lag + English long-lag values (frequency histogram)

# Flege & Hammond (1982)



**Figure 1.** Frequency of VOT values measured in stops produced by three groups of speakers.

# The Full Access Hypothesis

## Conclusions

- 1) Monolinguals can detect and store in memory small phonetic differences differentiating dialects of L1
- 2) Through familiarity with foreign-accented L1 speech, monolinguals can detect & store in memory phonetic differences arising from L1-L2 phonetic differences

# The Full Access Hypothesis

## Conclusions

- 3) Through familiarity with L2, bilinguals can detect & store in memory phonetic differences between native speakers and L2 learners arising from L1-L2 phonetic differences
- 4) Consistent with Full Access Hypothesis

# Outline

1. Arguments for a loss of plasticity
2. Counter arguments
3. **Factors affecting L2 speech perception & production**
4. Access to the properties of L2 speech sounds
5. Plasticity

# Factors affecting L2 speech

- Age of first exposure to L2 speech
- More native-like L2 production by individuals first exposed to L2 as children (early learners) than as adults (late learners)

# Factors affecting L2 speech

- However, some late learners in native-speaker range
- Example: production of word-initial English stops by native speakers of Spanish (Flege (1991))

# Flege (1991)

	<i>N</i>	<i>Age</i>	<i>AOA</i>	<i>Length of Residence</i>	<i>English Use</i>
<i>Spanish monolingual</i>	10	30	--	--	--
<i>English monolinguals</i>	10	26	--	--	--
<i>Early S-E bilinguals</i>	10	23	2	21	82%
<i>Late S-E bilinguals</i>	10	34	20	14	66%

# Flege (1991)

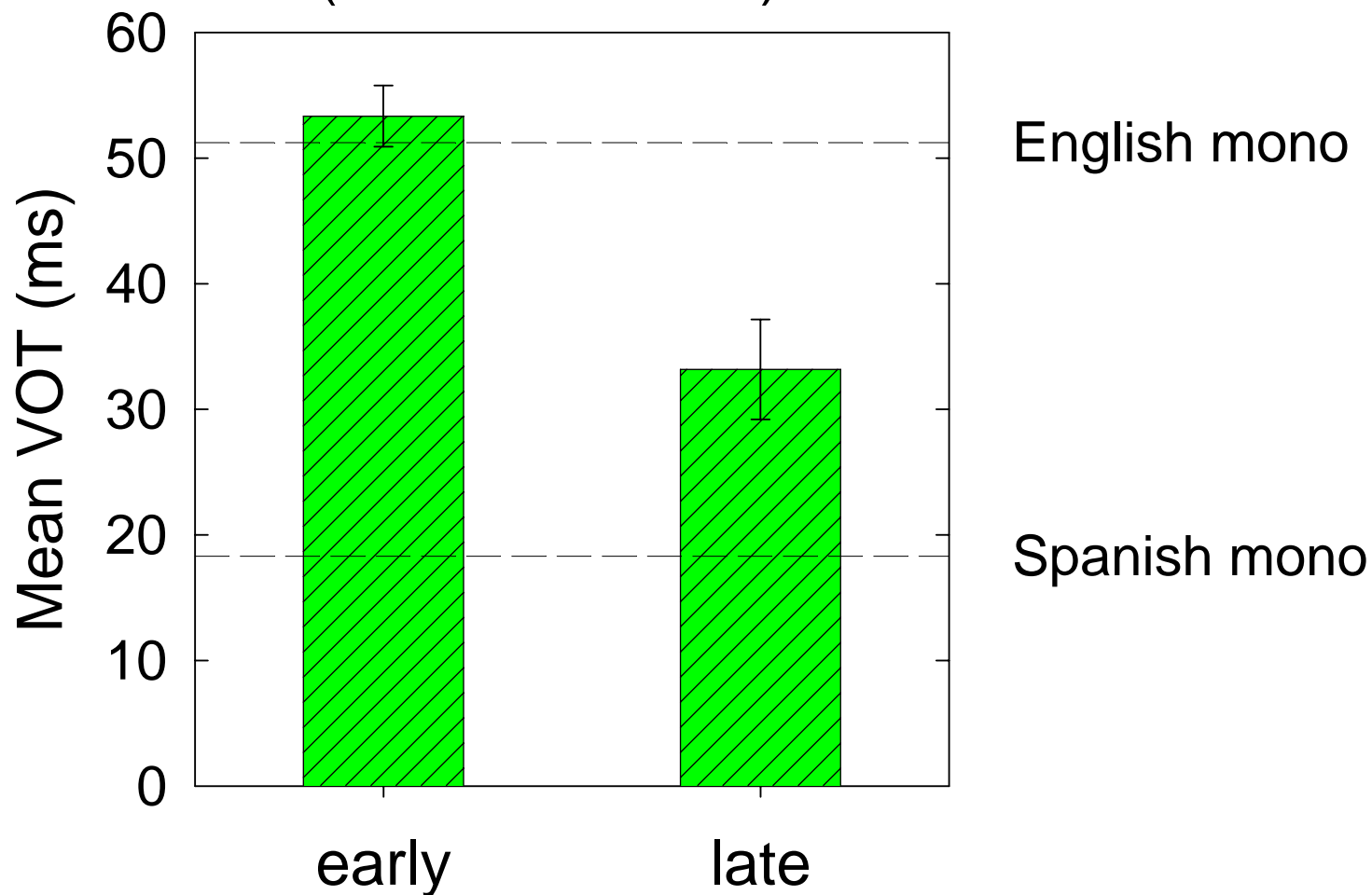
	<i>N</i>	<i>Age</i>	<i>AOA</i>	<i>Length of Residence</i>	<i>English Use</i>
<i>Spanish monolingual</i>	10	30	--	--	--
<i>English monolinguals</i>	10	26	--	--	--
<i>Early S-E bilinguals</i>	10	23	2	21	82%
<i>Late S-E bilinguals</i>	10	34	20	14	66%

# Flege (1991)

	<i>N</i>	<i>Age</i>	<i>AOA</i>	<i>Length of Residence</i>	<i>English Use</i>
<i>Spanish monolingual</i>	10	30	--	--	--
<i>English monolinguals</i>	10	26	--	--	--
<i>Early S-E bilinguals</i>	10	23	2	21	82%
<i>Late S-E bilinguals</i>	10	34	20	14	66%

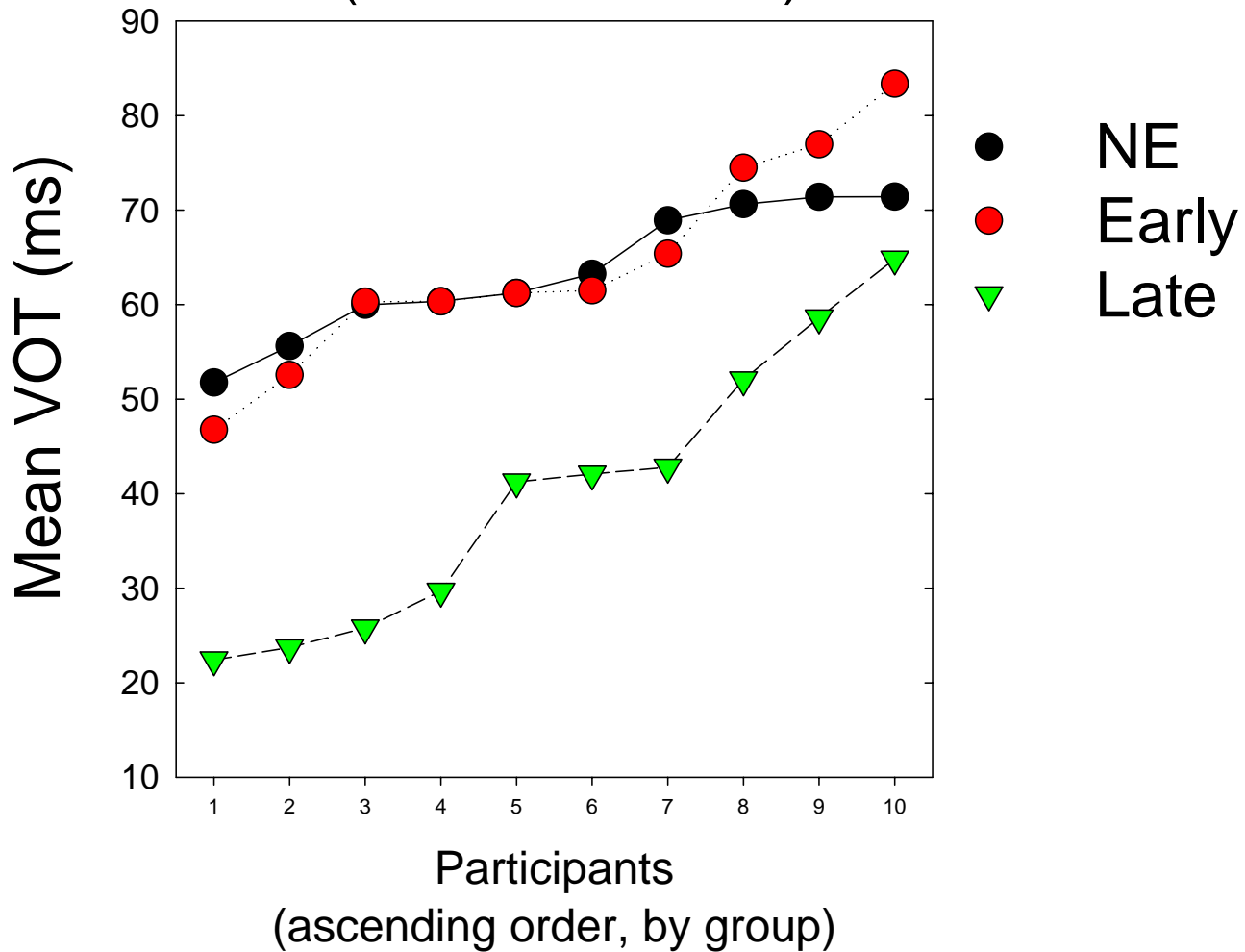
# Flege (1991)

word-initial /t/  
(utterance initial)



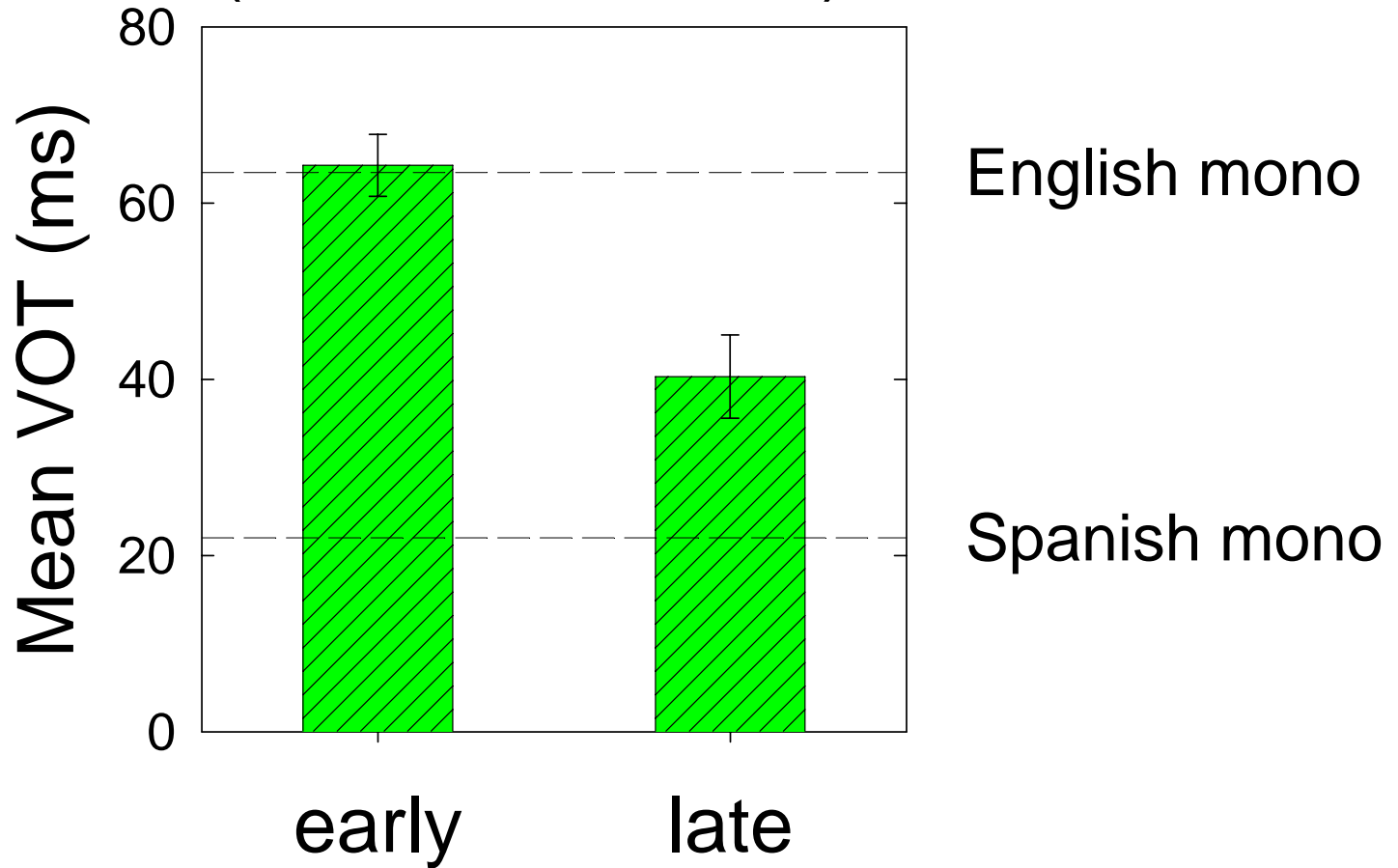
# Flege (1991)

word-initial /t/  
(utterance initial)



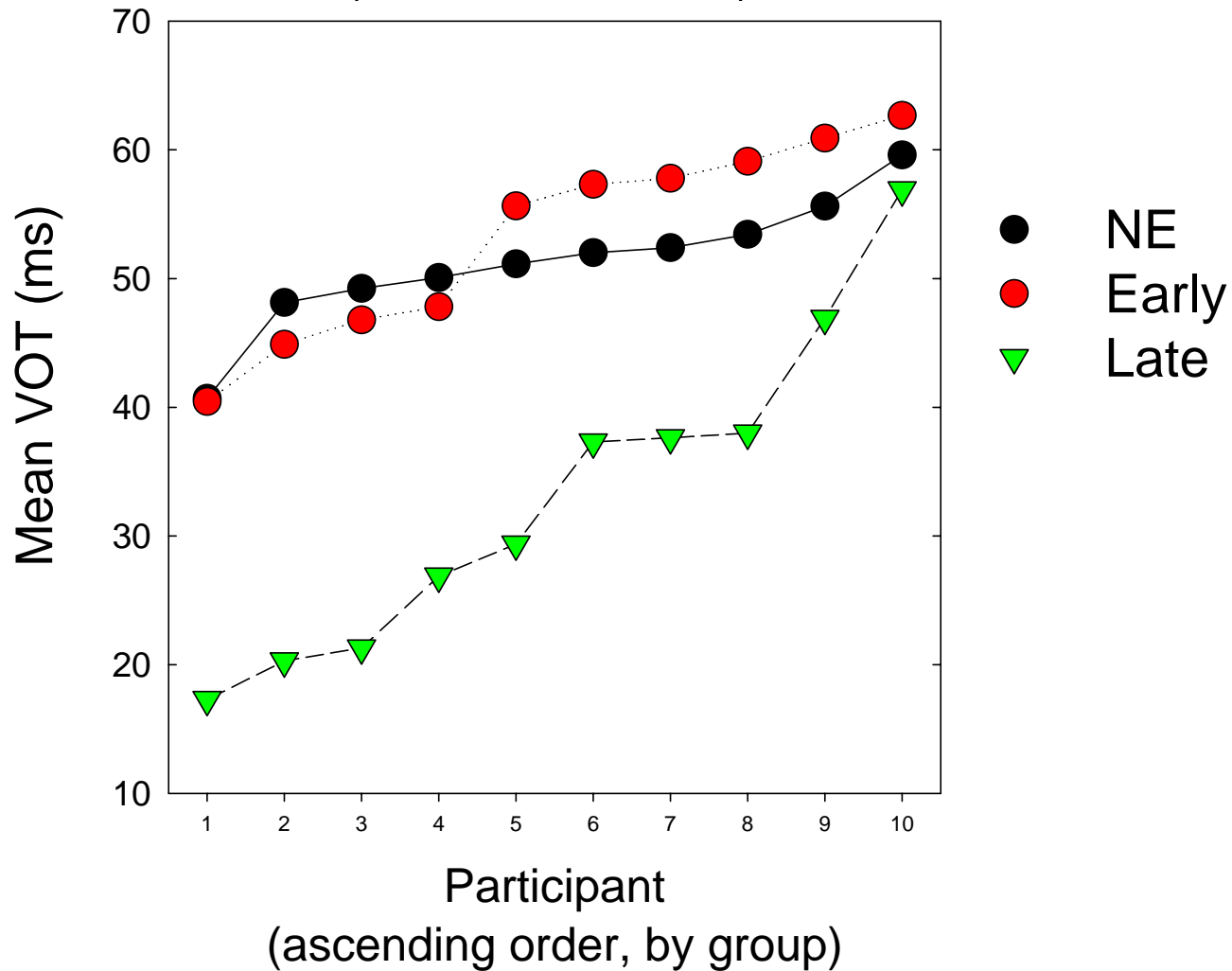
# Flege (1991)

word-initial /t/  
(utterance medial)



# Flege (1991)

word-initial /t/  
(utterance medial)



# Factors affecting L2 speech

- Language use
- Studies examining 72 Italian immigrants to Canada
  - Flege & MacKay (2004)
  - Piske, Flege, MacKay & Meador (2002)
  - Piske, MacKay & Flege (2001)
  - MacKay, Meador & Flege (2001)

# Participants

	<i>N</i>	<i>Age</i>	<i>AOA</i>	<i>Italian Use</i>
<i>NE</i>	18	50	--	--
<i>early-low</i>	18	50	7	7%
<i>early-high</i>	18	49	8	43%
<i>late-low</i>	18	51	20	10%
<i>late-high</i>	18	49	20	53%

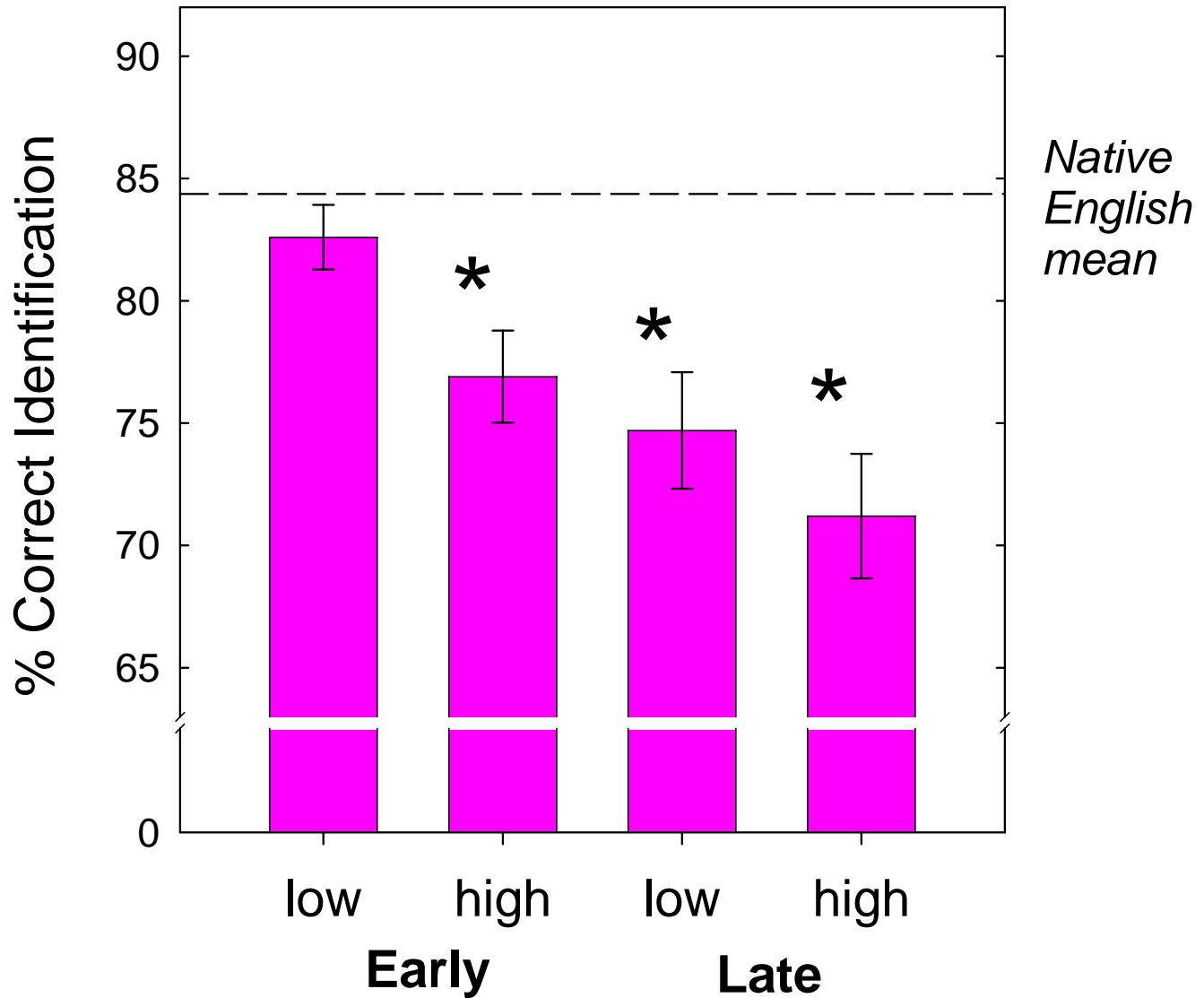
# Participants

	<i>N</i>	<i>Age</i>	<i>AOA</i>	<i>Italian Use</i>
<i>NE</i>	18	50	--	--
<i>early-low</i>	18	50	7	7%
<i>early-high</i>	18	49	8	43%
<i>late-low</i>	18	51	20	10%
<i>late-high</i>	18	49	20	53%

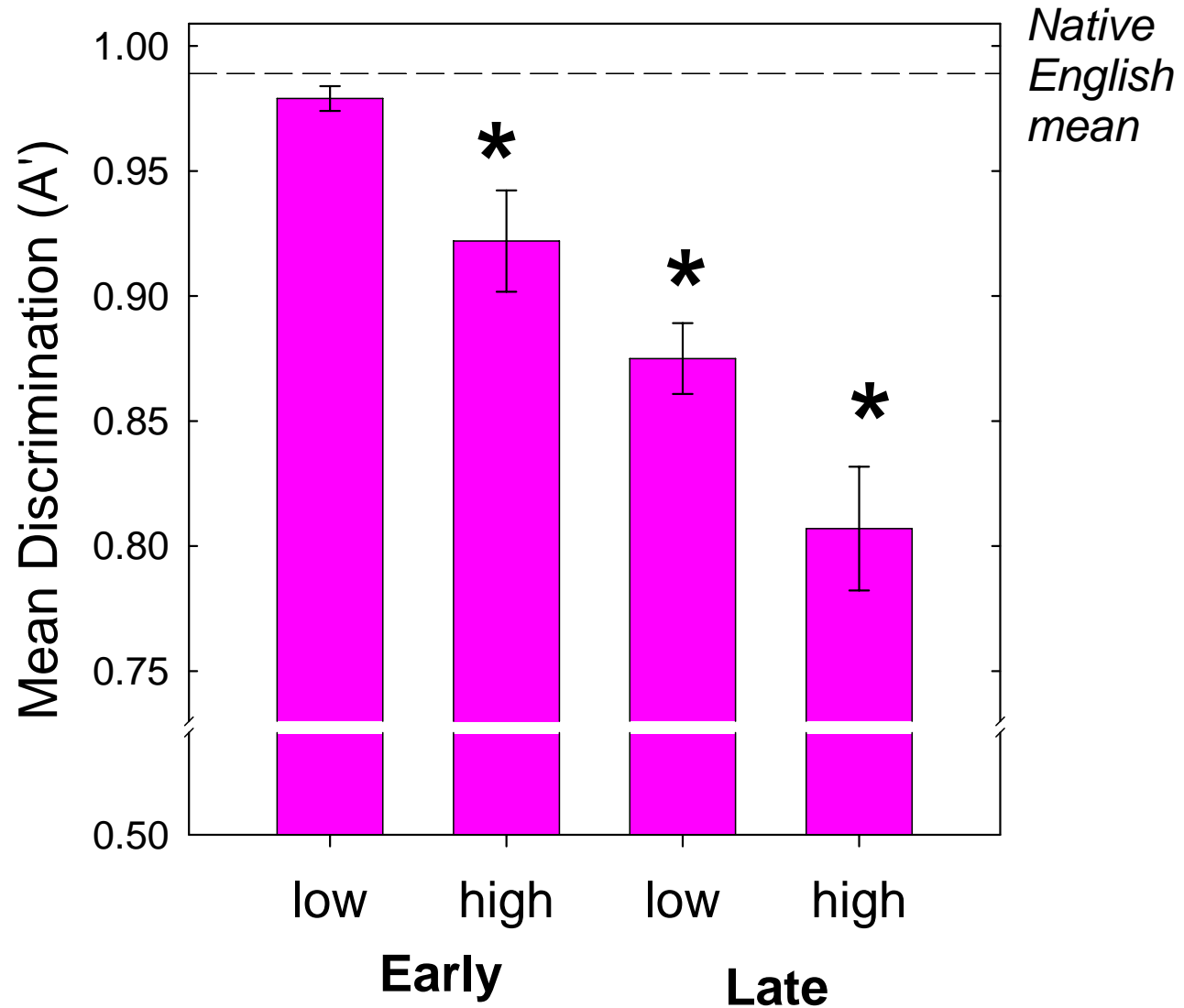
# Participants

	<i>N</i>	<i>Age</i>	<i>AOA</i>	<i>Italian Use</i>
<i>NE</i>	18	50	--	--
<i>early-low</i>	18	50	7	7%
<i>early-high</i>	18	49	8	43%
<i>late-low</i>	18	51	20	10%
<i>late-high</i>	18	49	20	53%

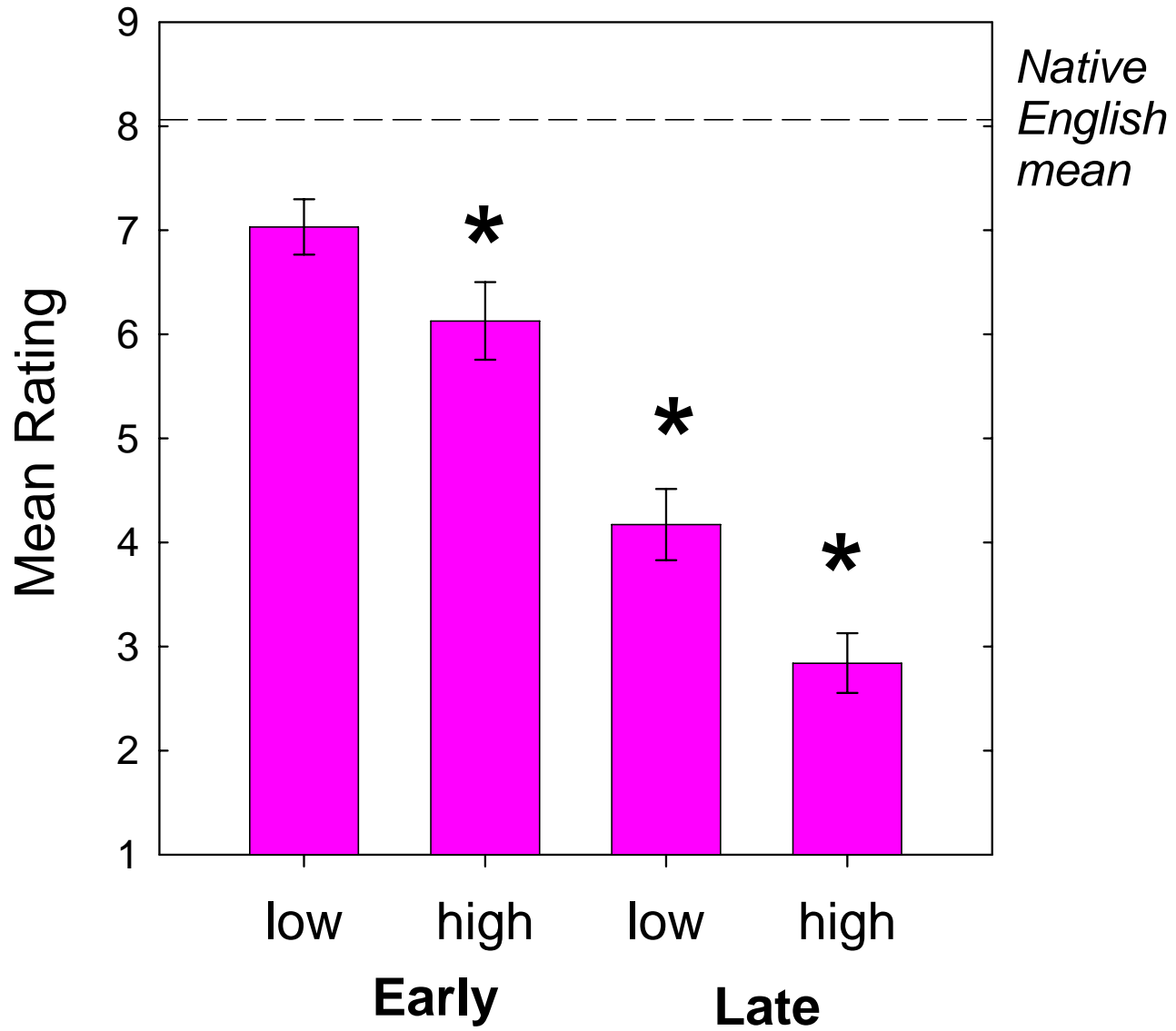
# Average identification of stops (/b d g p t k/) in Final Position



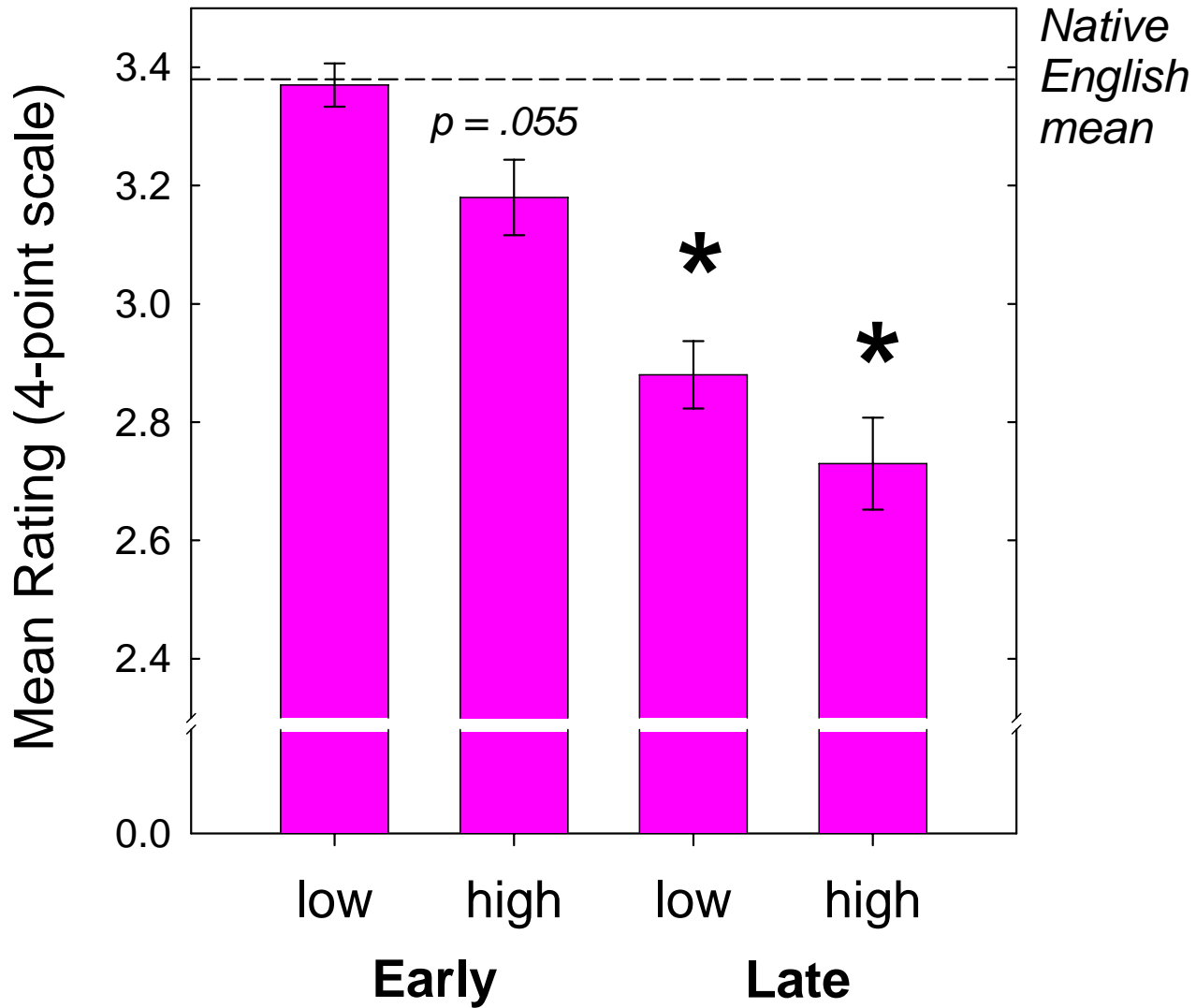
# Categorical Discrimination of /i/-/ɪ/, /ɛ/-/æ/ and /ɑ/-/ʌ/



# Overall FA



# Rated Accuracy of /i ɪ ε æ ɑ ʌ/ production



# Factors affecting L2 speech

## **Basis for “L1 use” effect uncertain**

- Not enough L2 input for high-L1-use group?
- Too much foreign-accented L2 input?
- Greater difficulty separating L1-L2 phonetic subsystems? (assumes that L1 system “stronger” if L1 used often)

# Factors affecting L2 speech

**Whatever the explanation ...**

No general conclusions regarding L2 plasticity possible without considering quantity and quality of L2 input

# Outline

1. Arguments for a loss of plasticity
2. Counter arguments
3. Factors affecting L2 speech perception & production
4. **Perceptual access to the properties of L2 speech sounds**
5. Plasticity

# Access to L2 speech properties

McAllister, Flege & Piske (2002)

**Aim:** determine if adults learn to perceive and produce phonetic distinctions based on a feature not used to contrast meaning in L1

## McAllister et al. (2002)

- Examined perception & production of Swedish vowels by L2 learners
- All experienced speakers of Swedish (> 10 years in Stockholm)

## McAllister et al. (2002)

Focused on distinctions between long-short Swedish vowels (4 pairs)

- mid vowels – almost exclusively duration
- high & mid vowels – duration differences accompanied by spectral quality differences

# McAllister et al. (2002)

## **Participants**

- 20 native speakers each of English and Spanish
  - [length] not used to distinguish vowel phonemes (meaning) in English or Spanish

# McAllister et al. (2002)

## Participants

- 20 native speakers each of English and Spanish
  - [length] not used to distinguish vowel phonemes (meaning) in English or Spanish
- 20 Estonians as control group
  - [length] used to distinguish Estonian vowels

# McAllister et al. (2002)

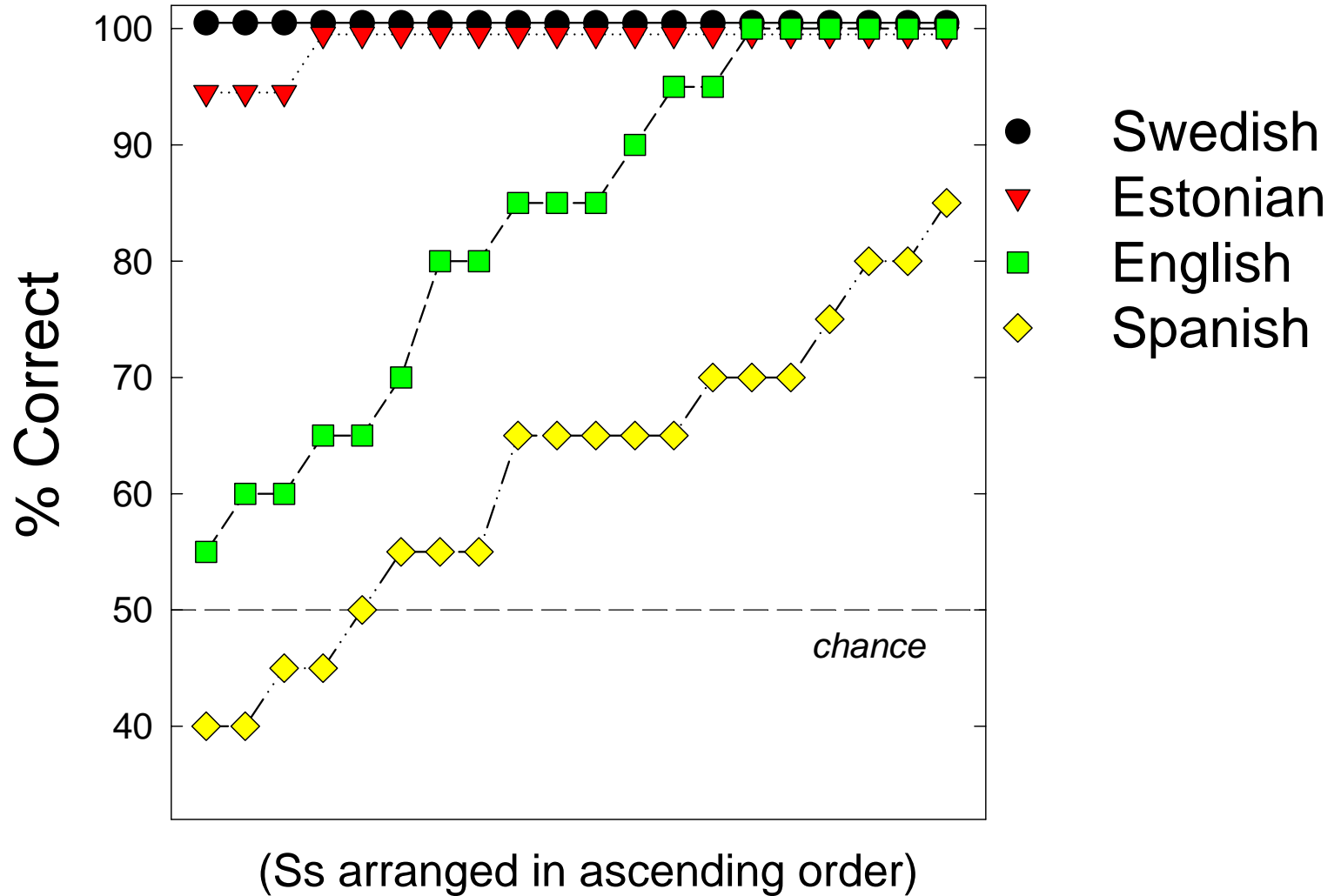
## Stimuli

- naturally produced Swedish words containing long or short vowels
- versions of same words with modified quantity (long → short, short → long)
- The quantity modifications created non-words

## McAllister et al. (2002)

- Participants produced real-word stimuli after hearing a definition  
(e.g., say “castle” after being cued by “place where a king and queen live”)
- Later, original & modified stimuli presented in random order following the same definitions
- **Perceptual task:** decide if each stimulus was “correct”

# Contrast between /ø/-/ø:/'

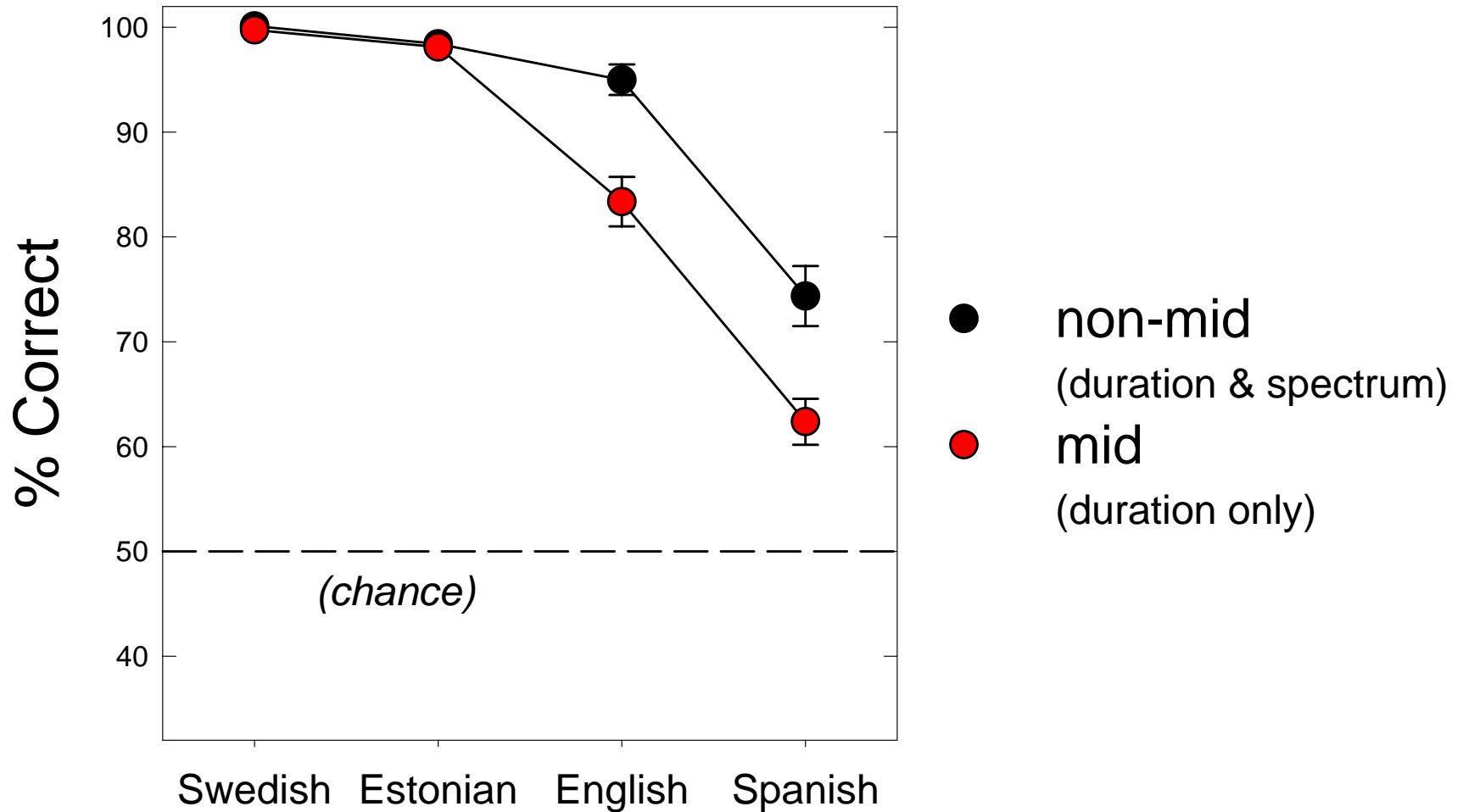


# McAllister et al. (2002)

## Separate analyses for

- **mid vowel pairs** (contrasts based almost entirely on duration)
- **high and low vowel pairs** (contrasts based on duration and spectral quality)

# McAllister et al. (2002)



# McAllister et al. (2002)

## **Conclusions**

- Estonians benefited from the presence of a [length] feature in L1

# McAllister et al. (2002)

## Conclusions

- English & Spanish participants performed better when Swedish long-short contrasts accompanied by feature (spectrum) used in L1
- Demonstrated difficulty using new (non-L1) feature

# McAllister et al. (2002)

## Conclusions

- However, above-chance performance of most participants – and excellent performance of some English participants – indicated that adult L2 learners can acquire sensitivity to a new feature ([length])

# Access to L2 speech properties

- English /ɚ/ very dissimilar from any Italian vowel
- Distinguished from other English vowels by a feature ([rhotic]) not used to distinguish Italian vowels

# Access to L2 speech properties

Aim of studies with Italian immigrants to Canada: test for the acquisition of a new feature in vowels [rhotic]

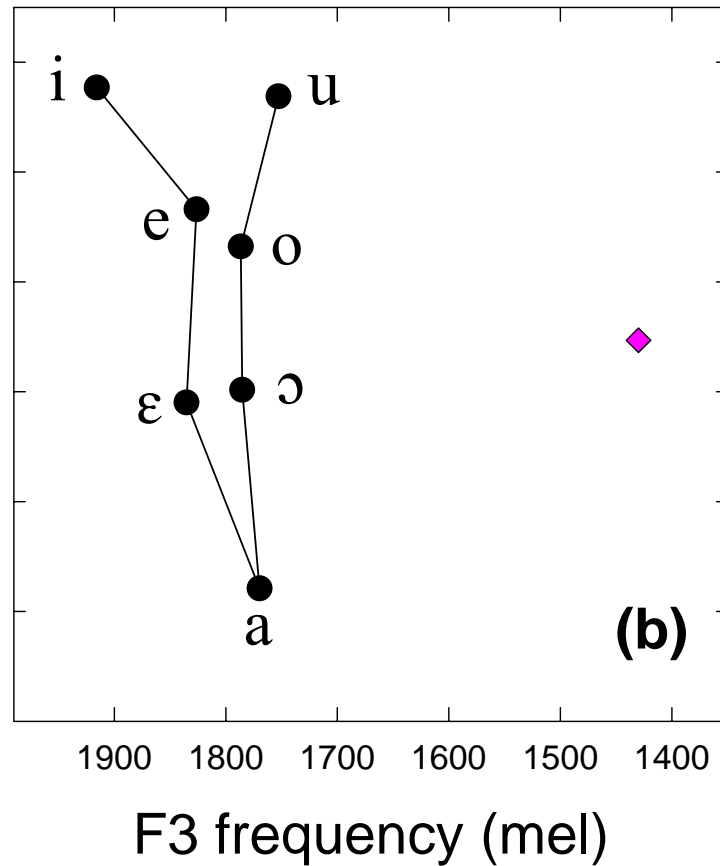
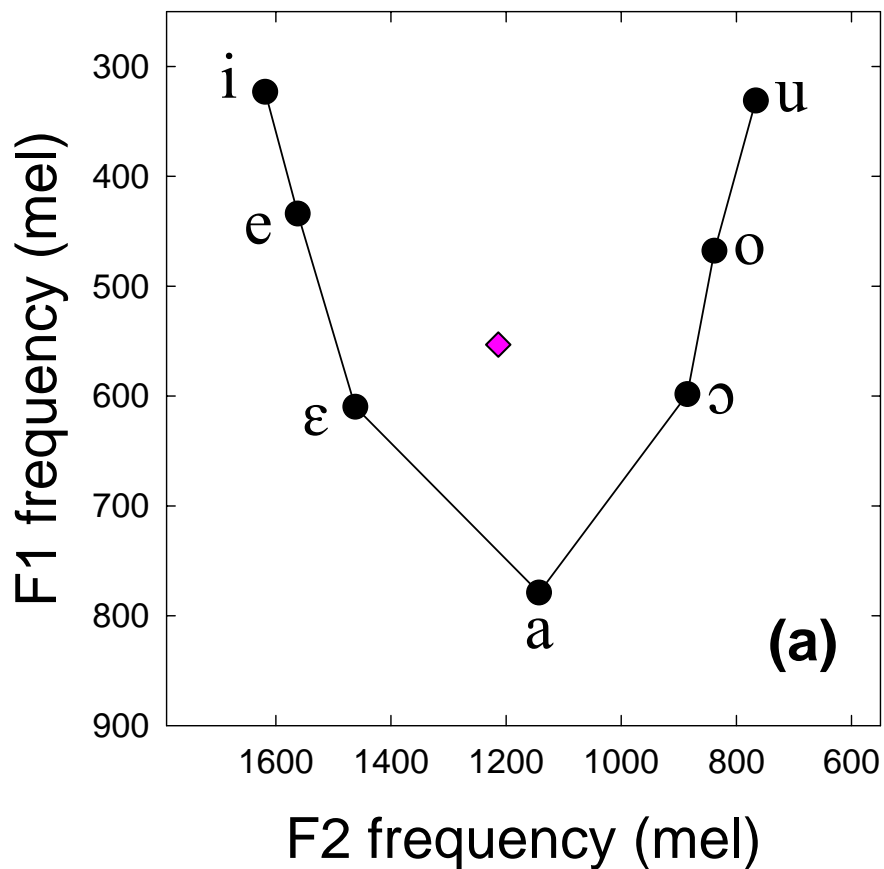
- Flege & MacKay (2004)
- Flege, Schirru & MacKay (2003)

## Flege & MacKay (2004)

Perceptual assimilation experiment suggested that English /æ/ is perceived to be phonetically distant from any Italian vowel

- Classifications in terms of Italian vowel categories –inconsistent
- Goodness of fit ratings – lower than for any other English vowel

● Italian vowels  
 ◆ English /ə/



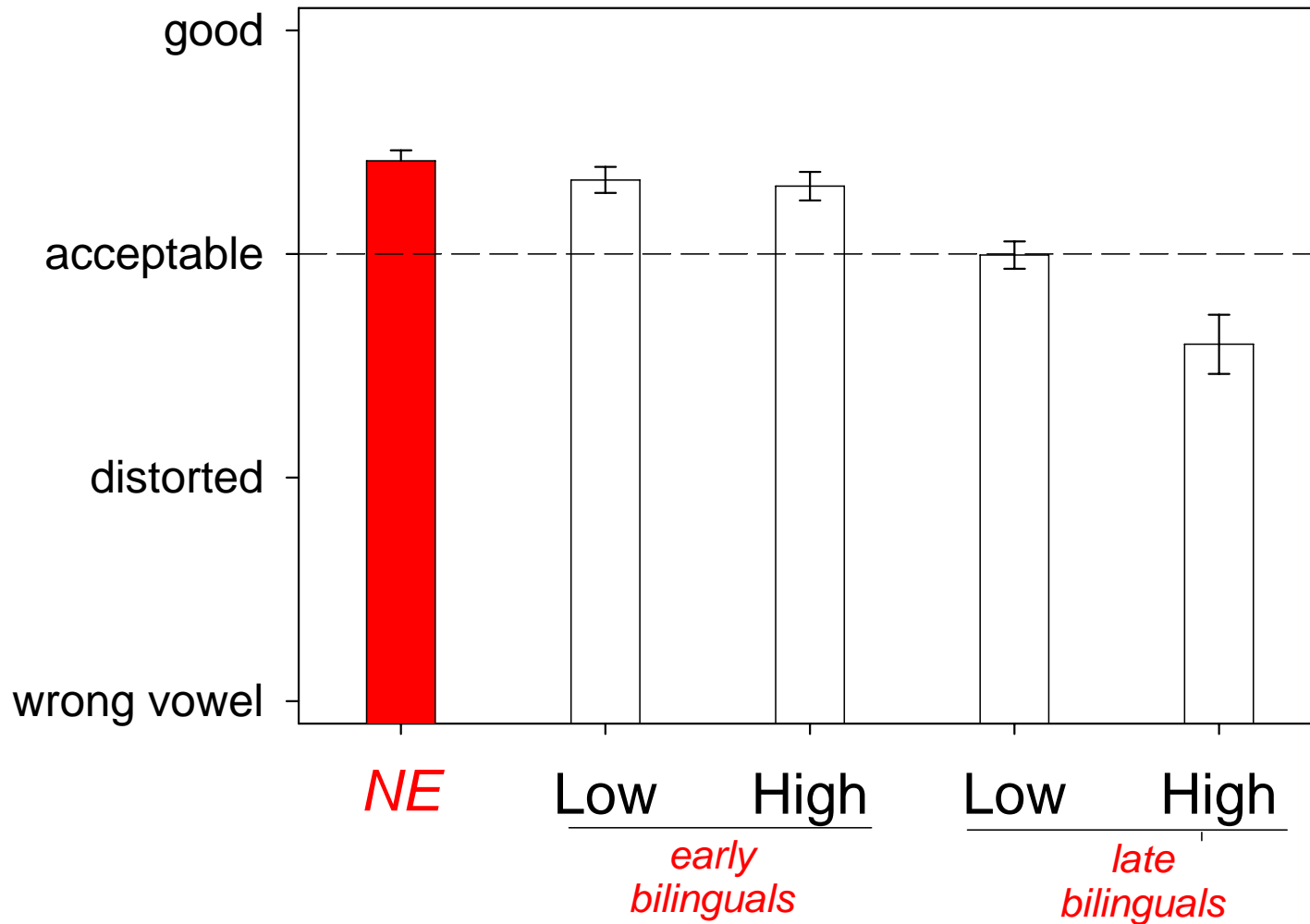
## Flege et al. (2003)

Examined /ɚ/ produced by 5 groups

- Native English
- 2 group of early Italian-English bilinguals (differed in L1 use)
- 2 groups of late Italian-English bilinguals

# Flege et al. (2003)

## Mean ratings of /æ/ production



## Flege et al. (2003)

- Statistical analyses (parametric, non-parametric) revealed
- NE obtained higher ratings (better pronunciation) than late learners
- Did not differ significantly from early learners

## Flege et al. (2003)

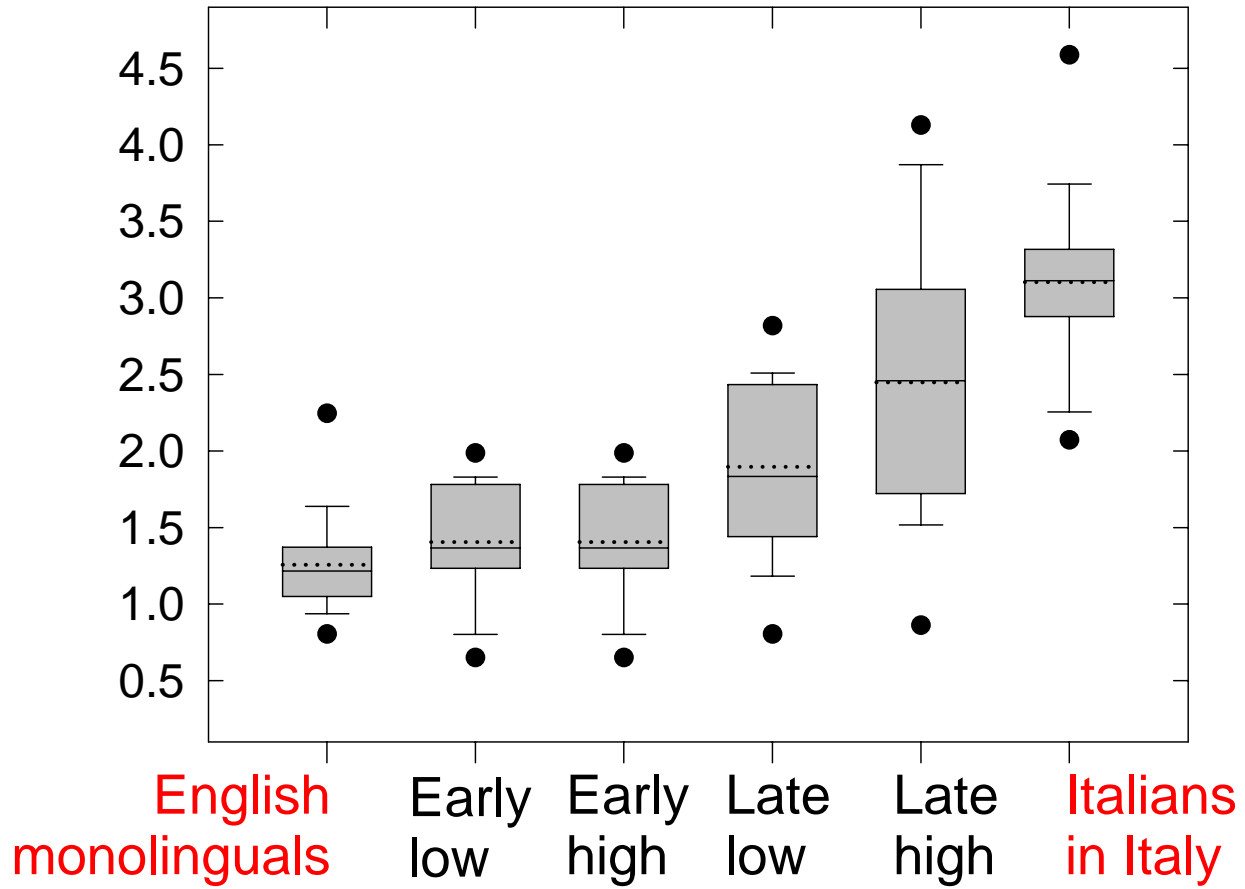
- Statistical analyses (parametric, non-parametric) revealed
- NE obtained higher ratings (better pronunciation) than late learners
- Did not differ significantly from early learners

Are late learners unable to acquire sensitivity to new feature in L2

## Flege et al. (2003)

- Acoustic analysis of /ɚ/ production by 5 groups
- Added to analysis: Italian monolinguals in Italy
- Dependent variable: Bark-transformed F3-F2 differences (index of [rhotic] feature)

# F3-F2, Barks (index of rhotic dimension)



## Flege et al. (2003)

- Late bilinguals produced significantly larger F3-F2 differences (less “rhotic” vowels) than early bilinguals
- Suggested they had not acquired sensitivity to [rhotic] feature
- However ...

## Flege et al. (2003)

- Late bilinguals produced significantly smaller F3-F2 differences (more “rhotic” vowels) than Italian monolinguals
- Indicated they had acquired sensitivity to [rhotic] feature
- Moreover, a few late learners were native-like

# Access to L2 speech properties

- Findings by [Iverson et al. \(2003\)](#) suggested that Japanese adults do not attend to appropriate phonetic features when perceiving English /r/ and /l/
- True for all Japanese adults?

## Yamada (1991)

- Tested 152 undergraduates in Japan
- Resembled participants in Iverson et al. (2003)
  - Adults, had never lived outside of Japan

# Yamada (1991)

- Stimuli: 4 naturally produced non-words pairs (e.g., *rosti-losti*)
- 1 hour of identification (2AFC) training

# Yamada (1991)

Substantial individual variation

- 77/152 participants (51%) remained at chance after training

However ...

# Yamada (1991)

- 2 could differentially identify /r/ and /l/ before training
- 9 (6%) did so in all 4 contrasts by end of training
- 53 (35%) did so for at least 1 of 4 pairs

# Access to L2 speech properties

Research with Japanese adults in US suggests that perceptual difficulty with /r/-/l/ may diminish over time

## MacKain et al. (1981)

- Tested groups of Japanese adults who differed in
  - use of English (29% vs. 55%)
  - Years of English use in the US (0.7 vs. 2.3 years)
- Synthetic /r/-/l/ continuum
- Identification & discrimination tests

## MacKain et al. (1981)

- 6/7 inexperienced Japanese participants showed “near-chance” performance on both tasks

## MacKain et al. (1981)

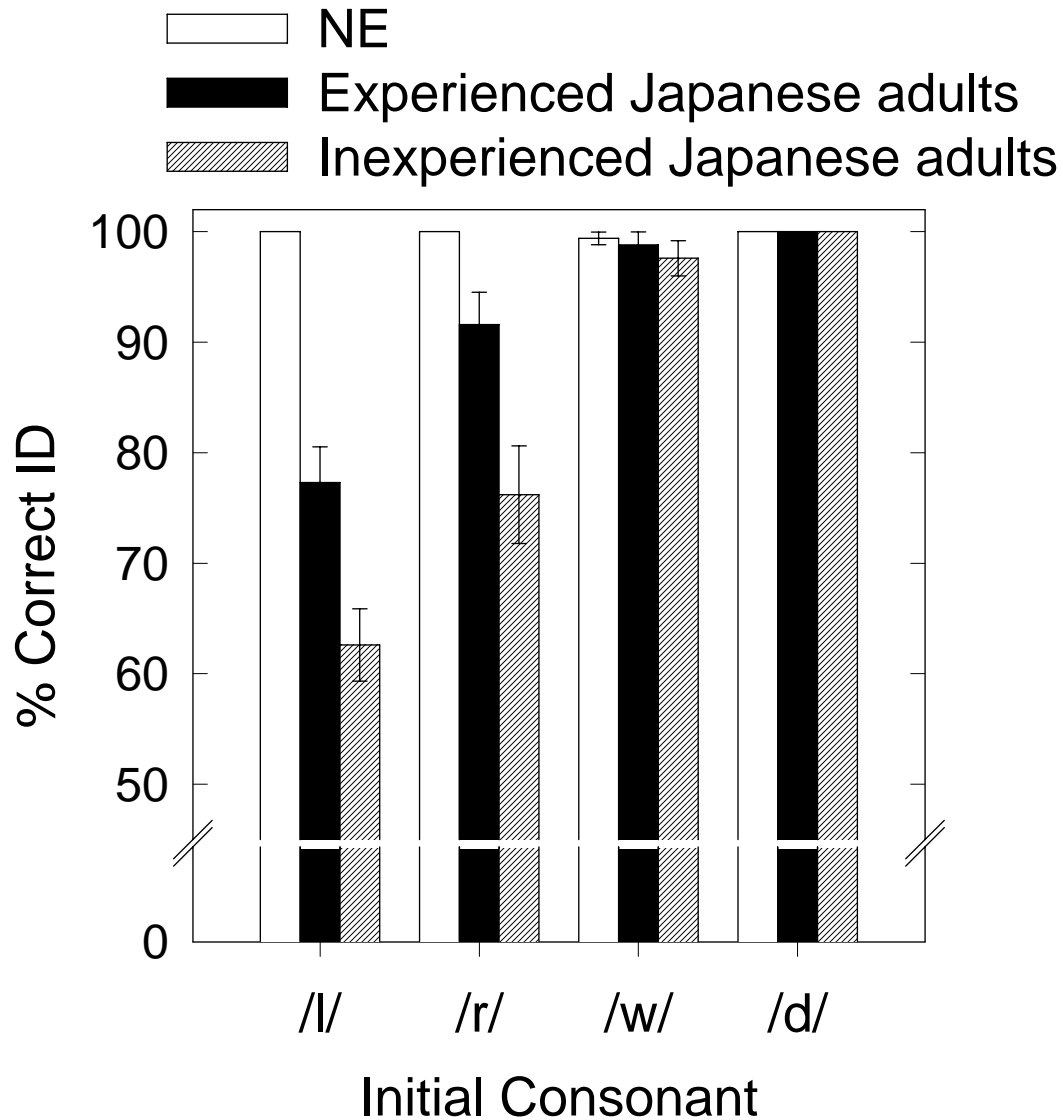
- 6/7 inexperienced Japanese participants showed “near-chance” performance on both tasks
- However, all 5 experienced participants resembled Native English adults
- Showed “categorical perception” of English word-initial /r/-/l/

## Flege et al. (1996)

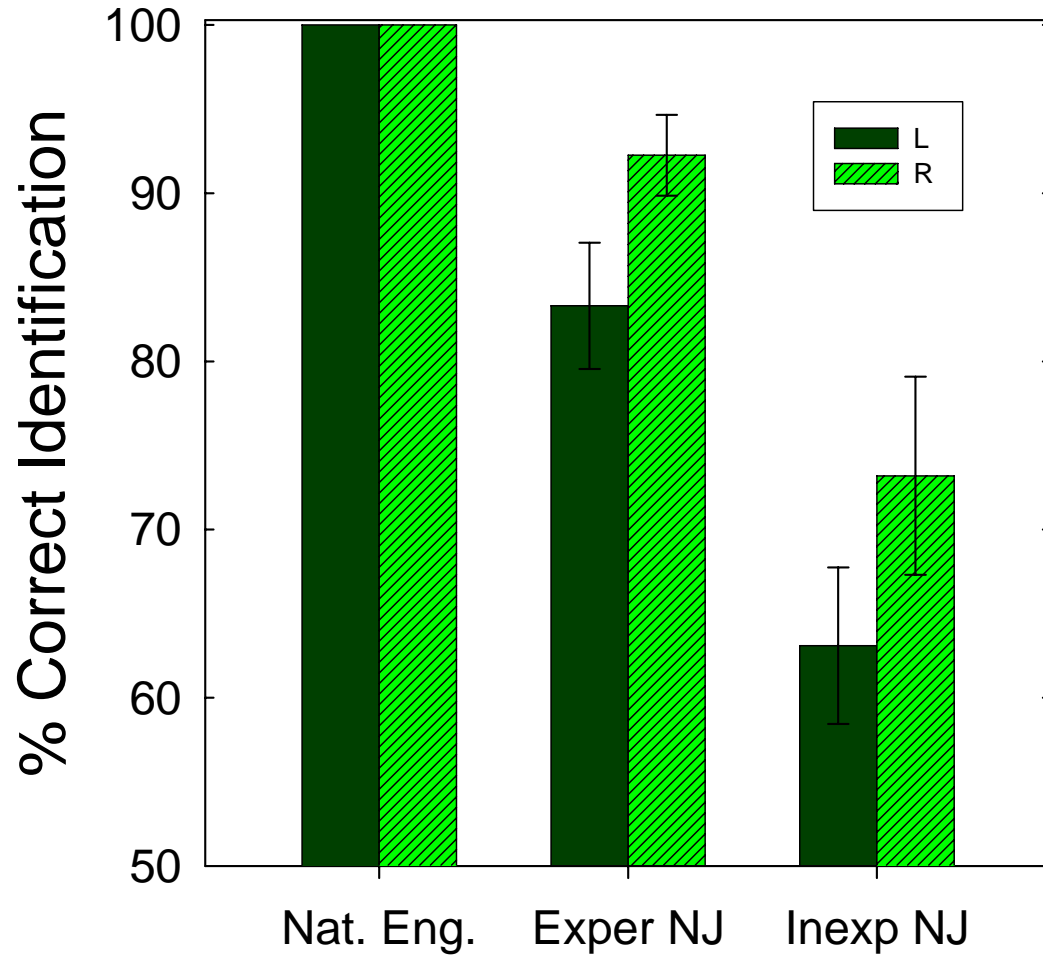
Tested groups of Japanese adults ( $n = 12$  each) who differed in years of residence in the US

- Inexperienced 1 - 4 years
- Experienced 12 - 29 years

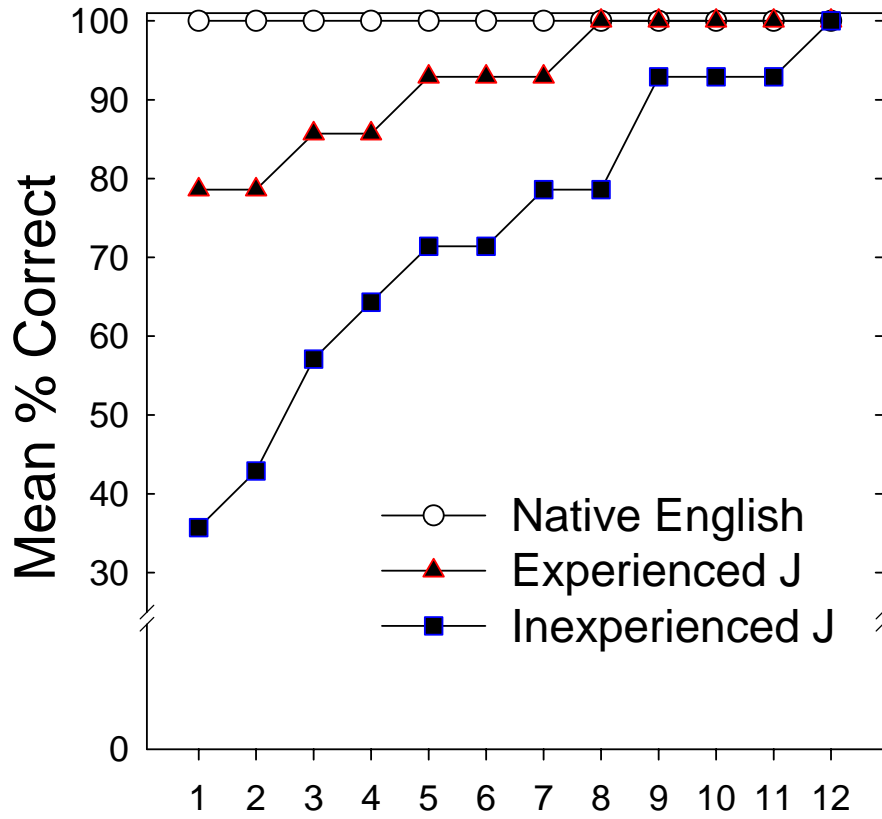
# Flege et al. (1996)



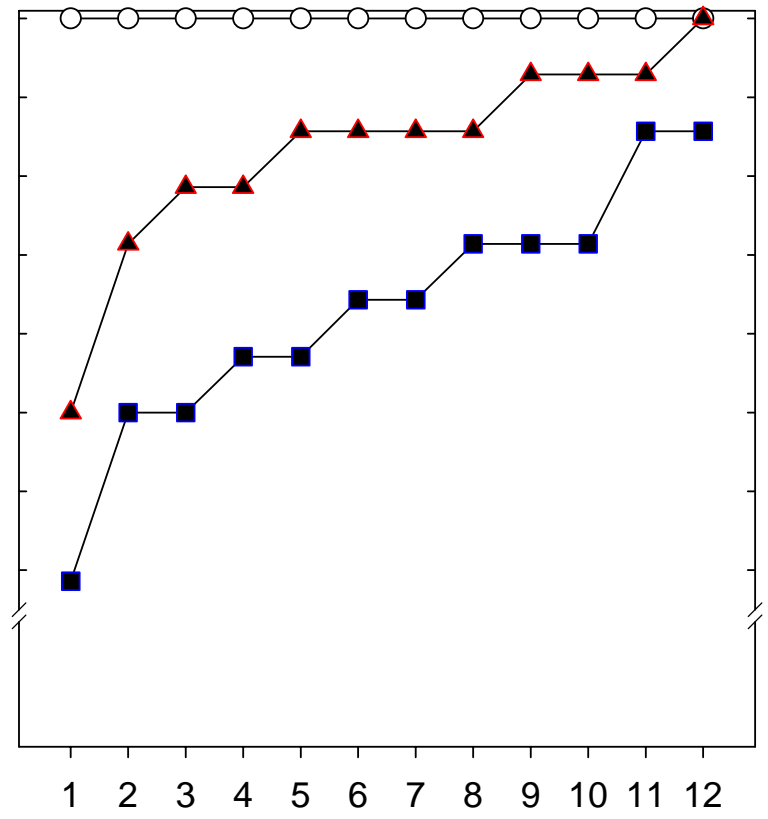
Identification of equally familiar minimally paired English words beginning in "r" and "l"



Identification of /r/



Identification of /l/



Subject

Access to L2 speech properties

**Why was /r/ identified better than //?**

- According to the Speech Learning Model (Flege 1995, 1999, 2002, 2003), the likelihood of a new category formation increases with perceived L1-L2 phonetic distance

# Access to L2 speech properties

- Japanese speakers identify initial English /r/ and /l/ tokens as the Japanese liquid, /R/
- However, English /r/ is rated as less /R/-like than English /l/
- The /r/-/l/ rating difference increases as a function of length of residence in the US (Aoyama & Flege, under review)

# Access to L2 speech properties

Perhaps, as Japanese adults gain conversational experience in English

- They gain perceptual access to phonetic features that distinguish English /r/ from /R/
- Some use this information to establish a new category for English /r/

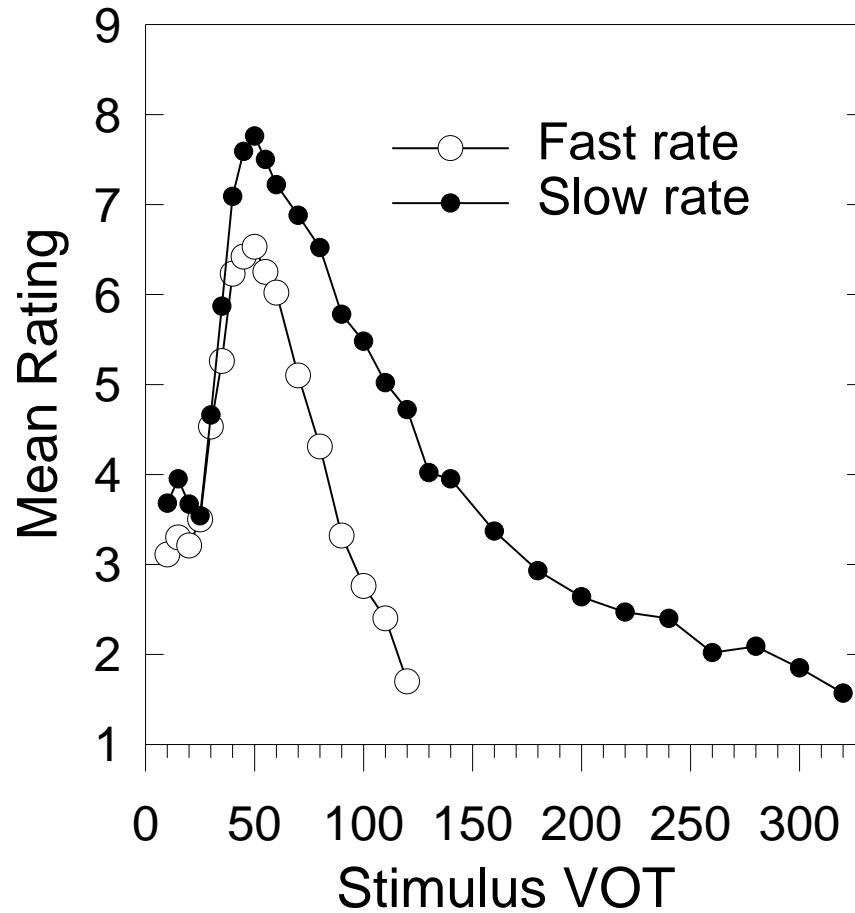
# Access to L2 speech properties

- Evidence for category formation in adults
- Research examining Spanish late learners of English

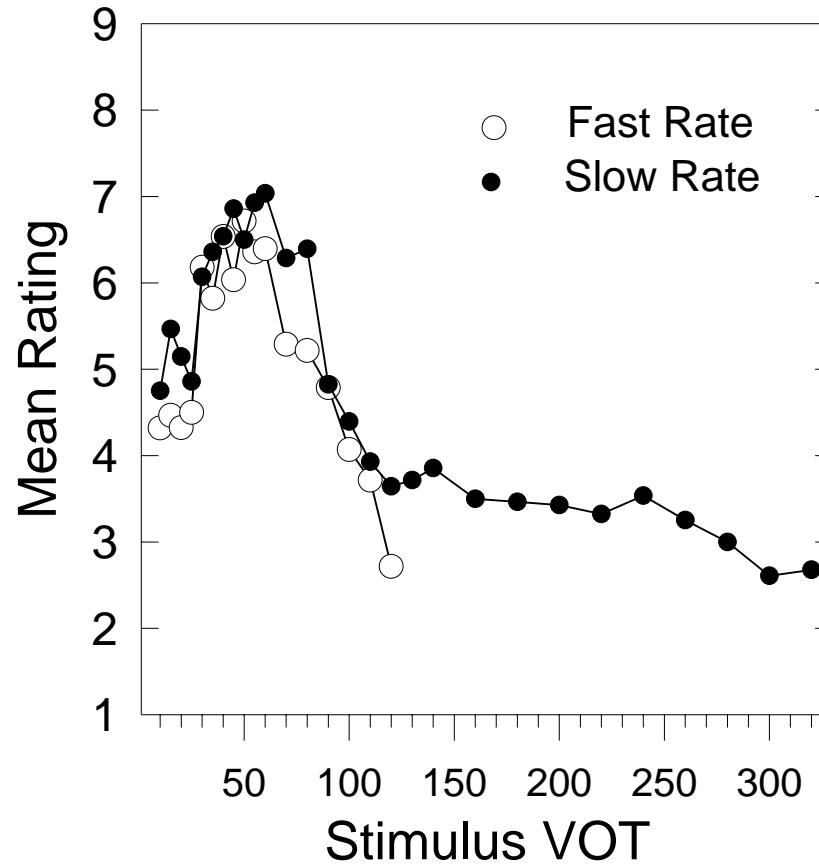
Flege, Schmidt & Wharton (1996)

Schmidt & Flege (1995)

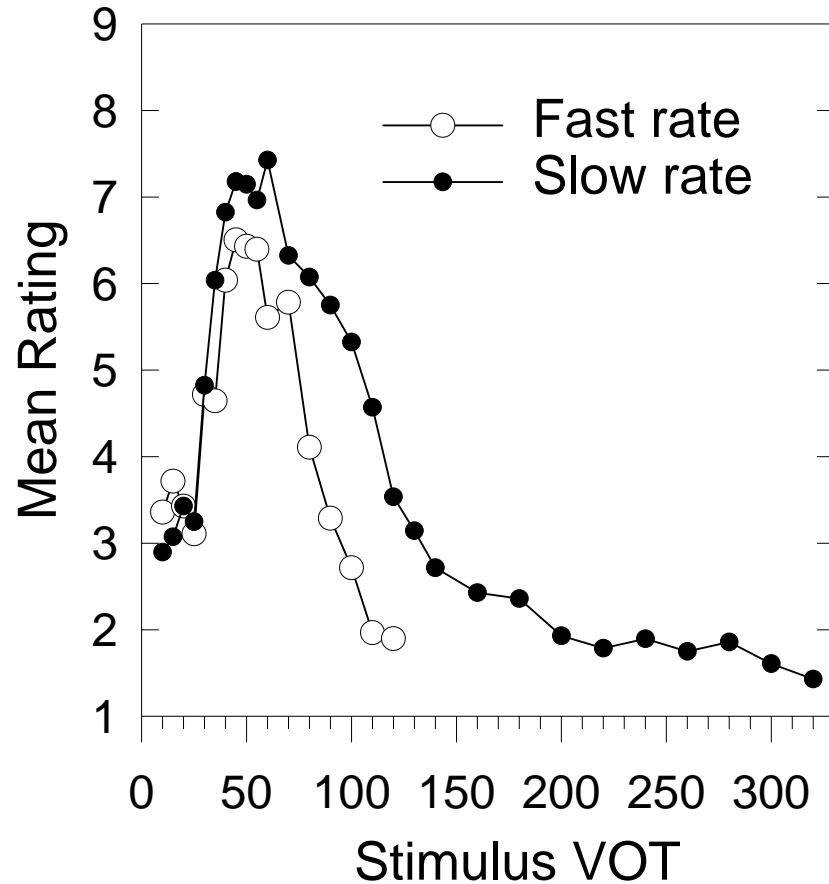
Native speakers of English  
show rate-dependent processing of  
stops differing in VOT



4 (of 15) late bilinguals who produced English /p/ with Spanish-like VOT values of 13-18 ms



# 4 (of 15) late bilinguals who produced English /p/ with English-like long-lag VOT values



# Outline

1. Arguments for a loss of plasticity
2. Counter arguments
3. Factors affecting L2 speech perception & production
4. Access to the properties of L2 speech sounds
5. **Plasticity**

# Plasticity

1. Must be evaluated by comparing groups of L2 learners to an appropriate native-speaker reference group
2. Significant difference between native-nonnative groups may suggest a “loss of plasticity”
3. However, much inter-subject variability L2 learners, especially late learners (e.g., Hazan et al. 2002)

# Plasticity

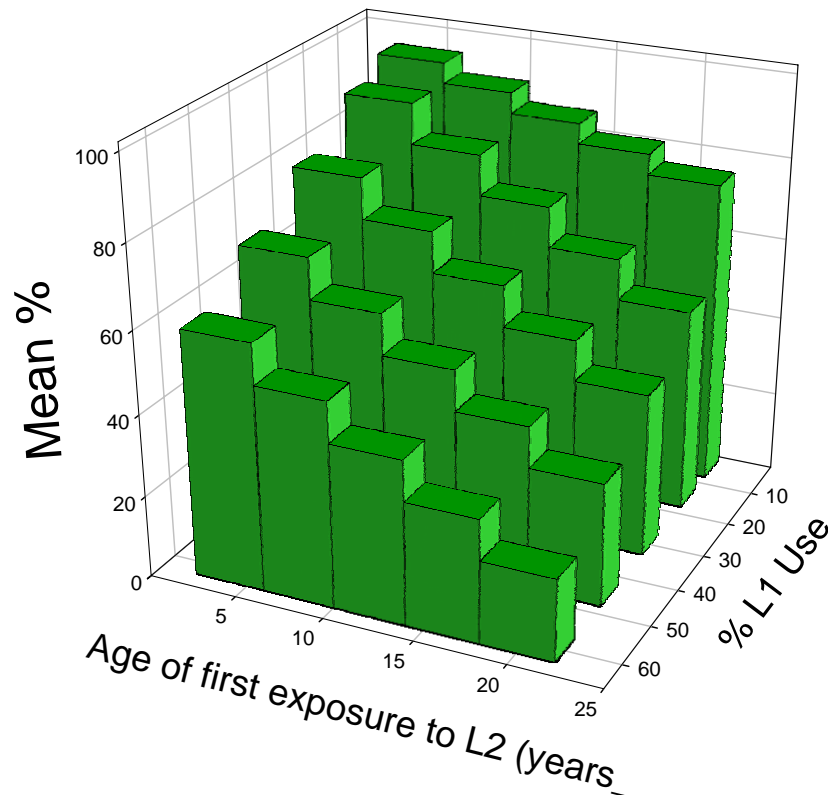
1. Must be evaluated by comparing groups of L2 learners to an appropriate native-speaker reference group
2. Significant difference between native-nonnative groups may suggest a “loss of plasticity”
3. However, much inter-subject variability L2 learners, especially late learners (e.g., Hazan et al. 2002)

# Plasticity

1. Must be evaluated by comparing groups of L2 learners to an appropriate native-speaker reference group
2. Significant difference between native-nonnative groups may suggest a “loss of plasticity”
3. However, much inter-subject variability L2 learners, especially late learners (e.g., Hazan et al. 2002)

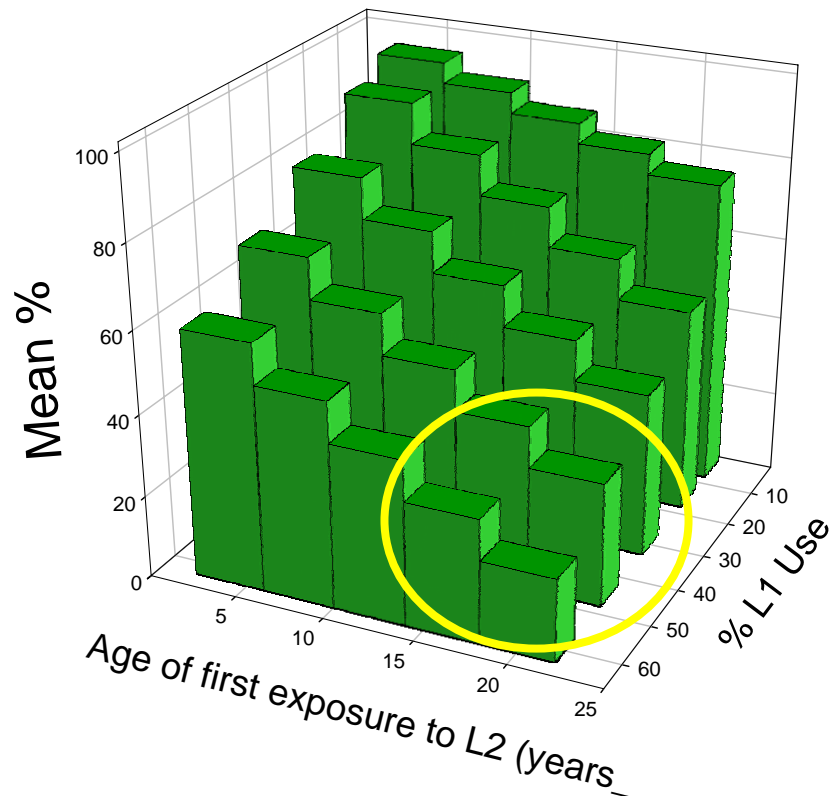
# Plasticity

Hypothetical  
% of Participants  
showing native-like performance



# Plasticity

Hypothetical  
% of Participants  
showing native-like performance



# Plasticity

- Source of inter-subject variability poorly understood

*phonological  
short-term  
memory*

*identification  
with L2 culture*

*strength of  
concern for  
pronunciation*

*musical  
ability*

*auditory  
acuity*

*mimicry  
ability*

*anxiety*

*language  
learning  
aptitude*

**Variation in  
Individual Per-  
formance?**

*introversion*

*instrumental  
motivation*

*bilingual  
balance*

*amount  
of L1 use*

*native-  
speaker  
input*

*age*

*L1*

*language  
dominance*

*total  
input*

*gender*

*integrative  
motivation*

*phonological  
short-term  
memory*

*identification  
with L2 culture*

*strength of  
concern for  
pronunciation*

*musical  
ability*

*auditory  
acuity*

*mimicry  
ability*

*anxiety*

*language  
learning  
aptitude*

**Variation in  
Individual Per-  
formance?**

*introversion*

*instrumental  
motivation*

*bilingual  
balance*

*amount  
of L1 use*

*native-  
speaker  
input*

*age*

*L1*

*language  
dominance*

*total  
input*

*gender*

*integrative  
motivation*

*phonological  
short-term  
memory*

*identification  
with L2 culture*

*strength of  
concern for  
pronunciation*

*musical  
ability*

**auditory  
acuity**

*mimicry  
ability*

*anxiety*

*language  
learning  
aptitude*

**Variation in  
Individual Per-  
formance?**

*introversion*

*instrumental  
motivation*

*bilingual  
balance*

*amount  
of L1 use*

*native-  
speaker  
input*

*age*

*L1*

*language  
dominance*

*total  
input*

*gender*

*integrative  
motivation*

*phonological  
short-term  
memory*

*identification  
with L2 culture*

*strength of  
concern for  
pronunciation*

*musical  
ability*

*auditory  
acuity*

*mimicry  
ability*

*anxiety*

*language  
learning  
aptitude*

**Variation in  
Individual Per-  
formance?**

*introversion*

*instrumental  
motivation*

*bilingual  
balance*

*amount  
of L1 use*

*native-  
speaker  
input*

*age*

*L1*

*language  
dominance*

*total  
input*

*gender*

*integrative  
motivation*

*phonological  
short-term  
memory*

*identification  
with L2 culture*

*strength of  
concern for  
pronunciation*

*musical  
ability*

*auditory  
acuity*

*mimicry  
ability*

*anxiety*

*language  
learning  
aptitude*

**Variation in  
Individual Per-  
formance?**

*introversion*

*instrumental  
motivation*

*bilingual  
balance*

*amount  
of L1 use*

*native-  
speaker  
input*

*age*

*L1*

*language  
dominance*

*total  
input*

*gender*

*integrative  
motivation*

# Plasticity

## **My suggestion**

If late-learner group differs significantly from native group, it is not realistic to conclude that late learners have lost plasticity IF some late learners show native-like performance

applies *a fortiori* to early learners

# Plasticity

## **caveats**

- William James (1890, p. 105) considered a system to be plastic if it were “weak enough to yield to an influence, but strong enough not to yield all at once.”
- Necessary to evaluate L2 learners who have been given a fair chance to learn (i.e., an abundance of primarily native speaker input)

# Plasticity

## **caveats**

- My suggestion would not apply if late learners if they ...
  - Resembled native speakers as the result of using different processes and/or mechanisms
  - Were found to differ from native speakers on highly sensitive tasks

# Plasticity: **conclusions**

## **More work needed to**

- Investigate both late and early learners who learned L2 under “optimal” conditions
- Understand the basis for inter-subject variability

End

Thanks for your attention

## References

- Aoyama, K. & Flege, J. (under review) Effects of English-language experience on Japanese adults' perceptual assimilation of English /r/ and /l/.
- Flege, J. (1988). Factors affecting degree of perceived foreign accent in English sentences. *J. Acoust. Soc. Amer.* 84:70-79.
- Flege, J. (1991) Age of learning affects the authenticity of voice onset time (VOT) in stop consonants produced in a second language. *J. Acoust. Soc. Amer.* 89:395-411.
- Flege, J. (1995) Second-language speech learning: Theory, findings, and problems. In W. Strange (Ed) *Timonium, MD: York Press* (pp. 229-273).
- Flege, J. (1999) Age of Learning and Second-language Speech., In D. Birdsong (Ed.) Hillsdale, NJ: Lawrence Erlbaum (pp. 101-132).
- Flege, J. (2002) Interactions between the Native and Second-language Phonetic Systems. In P. Burmeister et al. (Eds) *An Integrated View of Language Development: Papers in Honor of Henning Wode*. Trier: Wissenschaftlicher Verlag ( pp. 217-244).
- Flege, J. (2003) Assessing constraints on second-language segmental production and perception. In A. Meyer & N. Schiller (Eds) *Phonetics and Phonology in Language Comprehension and Production, Differences and Similarities*. Berlin: Mouton de Gruyter. Pp. 319-355.
- Flege, J. & Eefting, W. (1987) The production and perception of English stops by Spanish speakers of English. *J. Phonetics* 15: 67-83.
- Flege, J. & Hammond, R. (1982). Mimicry of non-distinctive phonetic differences between language varieties. *Studies Sec. Lang. Acquis.* 5:1-18.
- Flege, J. & MacKay, I. (2004) Perceiving vowels in a second language. *Studies in Sec. Lang. Acquis.* 26: 1-34.
- Flege, J. & Schmidt, A. (1995) Native speakers of Spanish show rate-dependent processing of English stop consonants. *Phonetica* 52, 90-111.

## References

- Flege, J. et al. (1996) Lexical familiarity and English-language experience affect Japanese adults' perception of /r/ and /l/. *J. Acoust. Soc. Amer.* 99: 1161-73.
- Flege, J., Schmidt, A. & Wharton, G. (1996) Age affects rate-dependent processing of stops of stops in a second language. *Phonetica*, 53, 143-161.
- Flege, J. et al. (1999) Native Italian speakers' production and perception of English vowels. *J. Acoust. Soc. Amer.* 106: 2973-2987.
- Flege, J. et al. (2003) Interaction between the native and second language phonetic subsystems. *Speech Comm.* 40: 467-91.
- Hazan, V. et al. (2002) Audiovisual perception in L2 learners. *Proceedings of Int.l Conf.r Spoken Lang. Proc.*, Denver, 16-20 Sept 2002, pp. 1685-1688.
- Iverson, P. et al. (2003) A perceptual interference account of acquisition difficulties for non-native phonemes. *Cognition* 87: B47-B57.
- James, W. (1890). *The Principles of Psychology* (H. Holt and Company, New York).
- Lenneberg, E. (1969) *Biological Foundations of Language*. New York: Wiley.
- MacKain, K. et al. (1981) Categorical perception of English /r/ and /l/ by Japanese bilinguals. *Applied Psycholing.* 2, 369-390.
- MacKay, I. et al. (2001) The identification of English consonants by native speakers of Italian. *Phonetica* 58, 103-125.
- McAllister, R. et al. (2002) The influence of the L1 on the acquisition of Swedish vowel quantity by native speakers of Spanish, English and Estonian. *J Phonetics* 30:229-258.
- Piske, T. et al. (2001) Factors affecting degree of foreign accent in an L2: A review. *J Phonetics* 29:191-215.
- Piske, T. et al. (2002) The production of English vowels by fluent early and late Italian-English bilinguals. *Phonetica* 59:49-71.
- Yamada, J. (1991). The discrimination learning of the liquids /r/ and /l/ by Japanese speakers. *J Psycholing. Res.*