

Factors Affecting the Pronunciation of a Second Language



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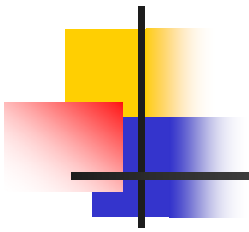
To obtain a copy of this talk ...

- ❖ jeflege@uab.edu
(Powerpoint file via the internet)
- ❖ copies of bibliography at the back

Outline of this talk



1. Definition of foreign accent (FA)
2. Why examine FA?
(effects of FA)
3. Scaling FA
4. Who has a FA?
5. Sources of FA



1. Defining foreign accent (FA)



FA defined

- FA is due to the influence of the L1 phonetic/phonological system on production of L2 vowels and consonants, stress, rhythm and intonation (Burgess, 2001)



FA defined

- “Non-pathological speech produced by L2 learners that differs in partially systematic ways from the speech characteristics of native speakers (Munro, 1998: 139)
- Degree of FA depends on "the extent to which an L2 learner's speech is *perceived* to differ from native speaker norms" (Munro & Derwing, 1998: 160)



2. Why study FA? (effects of FA)



Effects of FA

Negative evaluation

- In matched guise studies, accented and unaccented versions of the same speech samples are presented (*Anisfeld et al., 1962; Arthur et al., 1974; Ryan & Carranza, 1975*).
- Listeners don't know they have heard the same talker twice, in different "guises"
- Accented samples are consistently rated less favorably on scales ranging from, e.g., kind-cruel or intelligent-stupid.



Effects of FA

Misunderstanding of affect

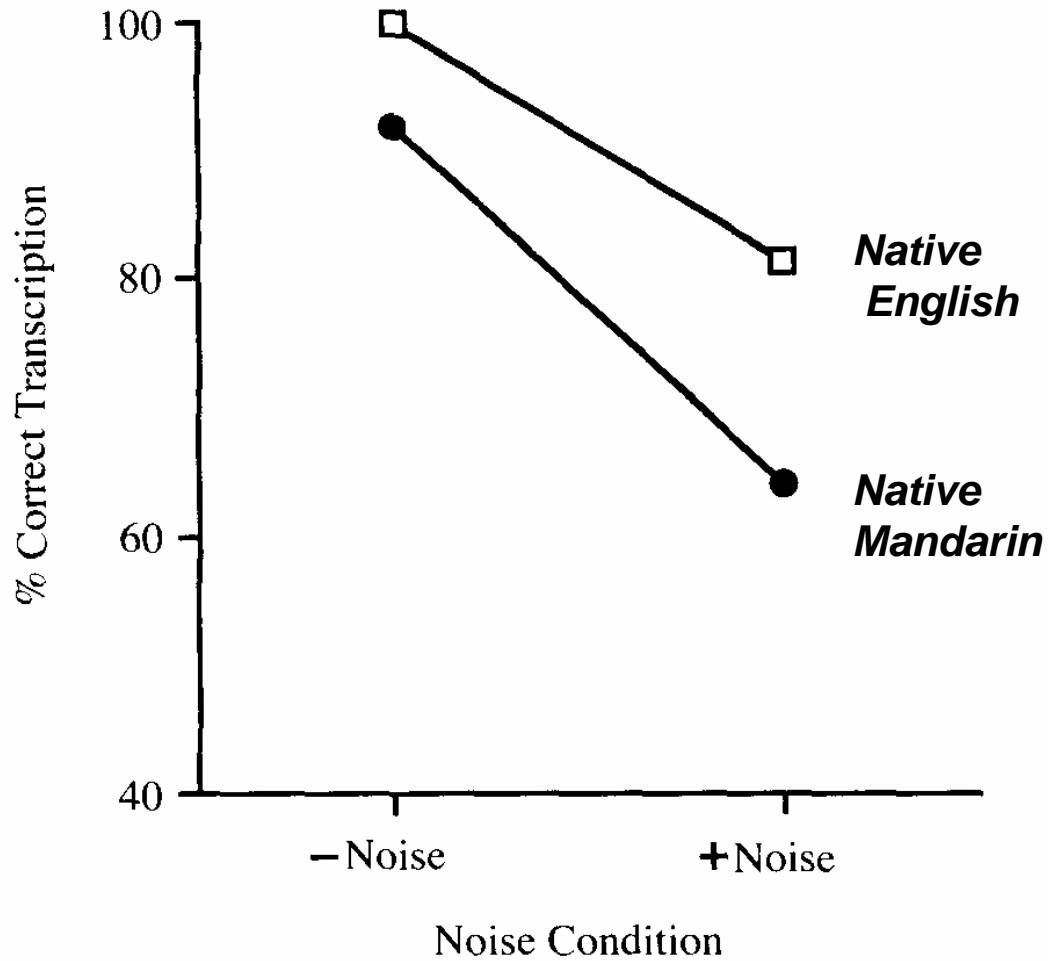
- Example from Cunningham-Andersson & Engstrand (1989, p. 139)
- A syntactic marker used in Lappish (a strong utterance-final F0 fall followed by a strong aspiration noise) is often used by Lappish speakers in Swedish
- This aspect of phonetic transfer is may be misinterpreted by Swedes as “an emotional expression of resignation”.



Effects of FA: intelligibility

- Foreign-accented speech is typically less intelligible than the unaccented speech of native speakers
- Munro (1998) examined the comprehension of sentences produced by native English and Mandarin adults
- Sentences presented for transcription in the quiet and in cafeteria noise (S/N = 7 dB).

Munro (1998)

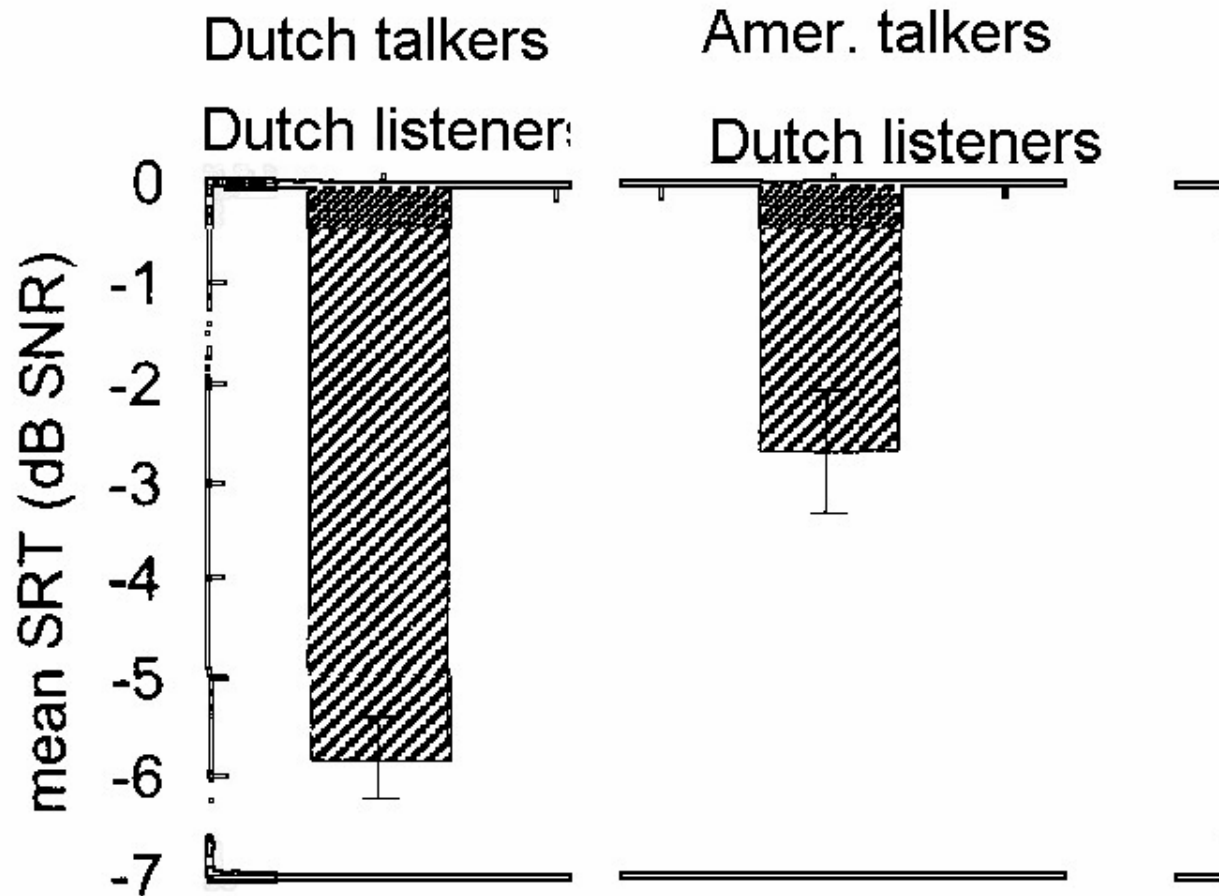




Effects of FA: intelligibility

- *Adding noise* seemed to have a slightly greater effect on foreign-accented than unaccented (native-produced) speech.
- Problem: NE group was at ceiling in the no-noise condition.
- Better measure of noise effect on nonnative speech is the Speech Reception Threshold (*SRT*) technique.
- DV = the S/N ratio at which 50% correct responses obtained for short, redundant, everyday sentences

Van Wijngaarden (2001)



FA \neq intelligibility



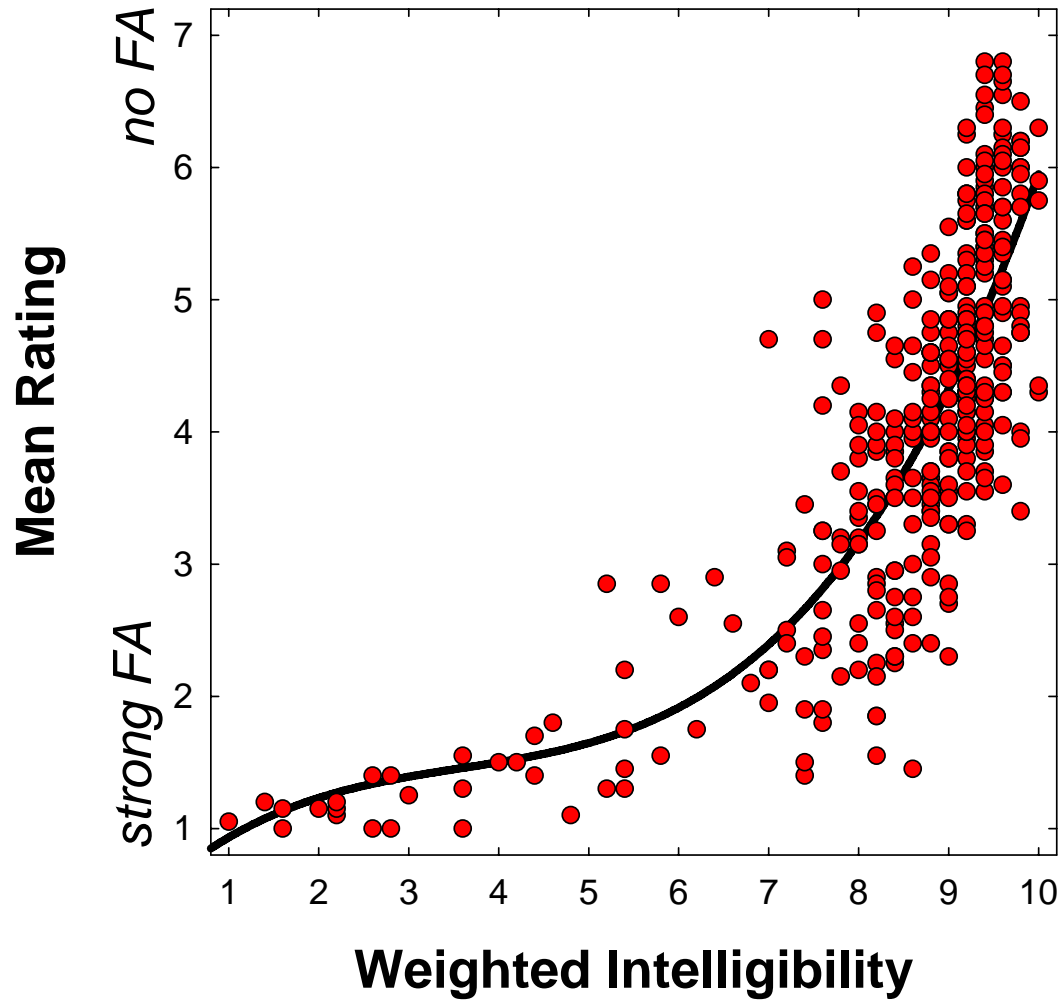
- Munro & Derwing (1995) examined FA and intelligibility in speech samples produced by 10 native Mandarin adults
- Most speech samples were “highly intelligible” but degree of FA varied considerably. Significant correlation between FA and intelligibility for only 5/18 listeners.
- Munro & Derwing (1997) examined 48 non-natives. Intelligibility-FA correlations observed for 20/26 listeners; mean $r = -.46$.



FA \neq intelligibility: Segments

- Flege et al. (1995) examined word-initial /r/ and /l/ tokens spoken by native English and native Japanese adults
- Consonants identified and also rated (7-point FA scale) by NE listeners
- Significant difference between native English and Japanese groups for FA ratings but not intelligibility

Intelligibility vs. FA in /r/ and // tokens





Effects of FA: slowed processing

- Three studies showed that even highly intelligible foreign-accented speech is processed more slowly than unaccented (native) speech
 - Munro & Derwing (1995b)
 - Schmid & Yeni-Komshian (1999)
 - Clark (2002)
- Probably due to mismatch between vowels and consonants in foreign-accented speech and native listeners' long-term memory representations



Effects of FA: slowed processing

- Munro & Derwing (1995b) examined sentences produced by native English and Mandarin adults
- The sentences were either True (e.g., *Elephants are big animals*) or False (e.g., *Most people wear hats on their feet*).
- The sentences were transcribed correctly (100% intelligible).

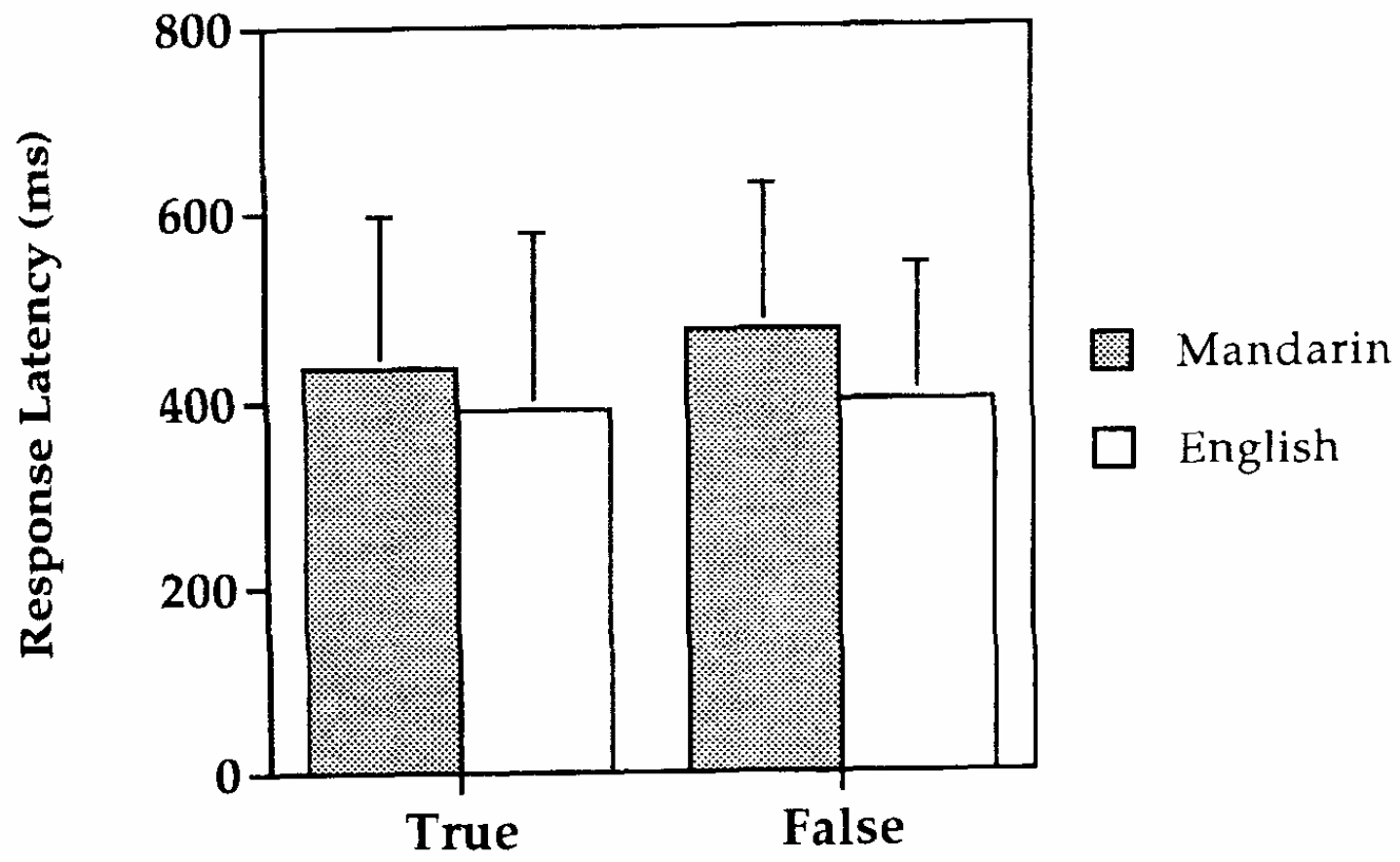


Effects of FA: slowed processing

- Task: respond T or F as rapidly as possible
- DV = the time needed respond (only correctly “verified” sentences examined)
- Significantly faster responses to unaccented than accented sentences (M = 62 msec)

Sentence verification task, results

M. J. Munro and T. M. Derwing

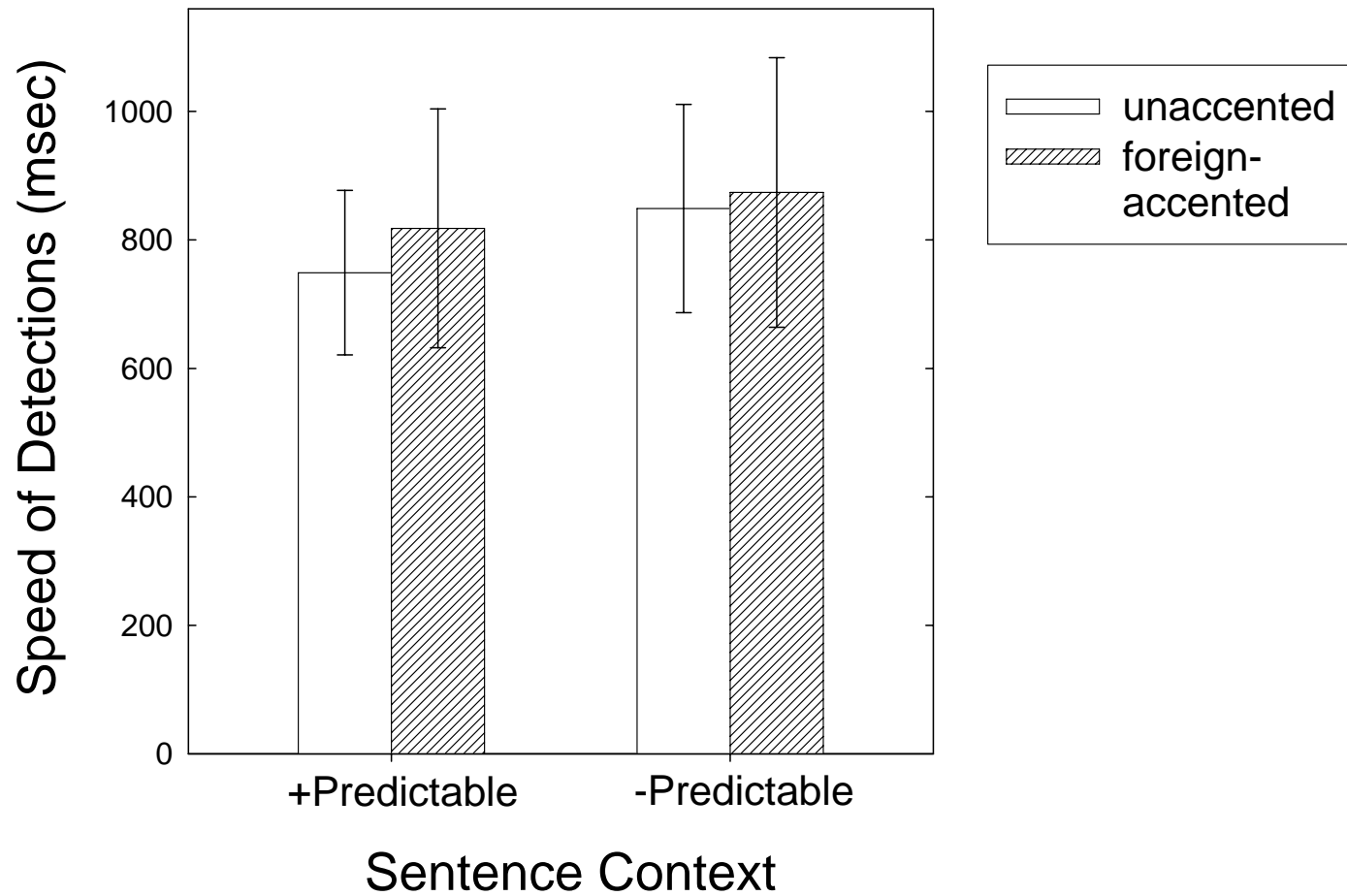




Effects of FA: slowed processing

- Schmid & Yeni-Komshian (1999) examined native English listeners' ability to detect intentional mispronunciations of words (e.g., “crib” → “grib”)
- High- and low-probability SPIN sentences produced by 4 native and 4 non-native speakers of English
- DV: speed of detection

Speed of detection





3. Scaling FA



Ways to assess FA

- Generate scores using an automatic testing system based on *speech recognition* technology (e.g., Neumeyer et al., 2000; Cucchiaroni et al., 2000)
- Make specific *acoustic measurements* (e.g., VOT in stop consonants; Major, 1987)
- Global ratings of trained or untrained *listeners*



Assessing FA

- Perceptual effect of measured native-nonnative acoustic phonetic differences is uncertain
- Therefore, *listener judgments remain the “gold standard”*

Scaling FA: Listener judgments



1. Have Ss repeat standard set of simple sentences following a filled delay (“delayed repetition” technique)
 - ❖ Provides specific prosodic model
 - ❖ Yields fluent utterances (no pauses, prolongations, repetitions)
 - ❖ Prevents listeners from being influenced by lexical & semantic errors (e.g., Derwing & Munro, 1997)

Scaling FA



2. Present productions of each sentence in separate counterbalanced blocks.

Make sure that the sentences examined contain a wide range of L2 vowels and consonants

Scaling FA



3. Randomly present productions of each sentence 4 times each. Take the median of the last 3 replicate judgments.
 - ❖ Why? Obtain stable FA ratings of each sentence from each listener

Scaling FA



- ❖ As native-speaking listeners grow familiar with a FA, it becomes more intelligible (e.g., Wingstedt & Schulman, 1987; Bradlow & Bent, 2001; Clark, 2002).
- ❖ As native-speaking listeners grow familiar with non-native speech, it may be judged as more strongly foreign-accented (Flege & Fletcher, 1992; Munro & Derwing, 1994)

Scaling FA



4. Include native speakers as controls, and to anchor listeners' ratings of nonnative speakers
 - ❖ FA ratings are not absolute. Flege & Fletcher (1992) showed that FA ratings are range-dependent
 - ❖ Example: Someone with a mild FA might appear to have a stronger FA if presented in a set with many native speakers

Scaling FA



5. Use mature native speakers as listeners
 - ❖ The ability to gauge degree of FA may develop in children learning English as their native language (Scovel, 1988)
 - ❖ Non-native listeners may not rate foreign accent in their L2 like native speakers of that language (Flege, 1988)



Flege (1988)

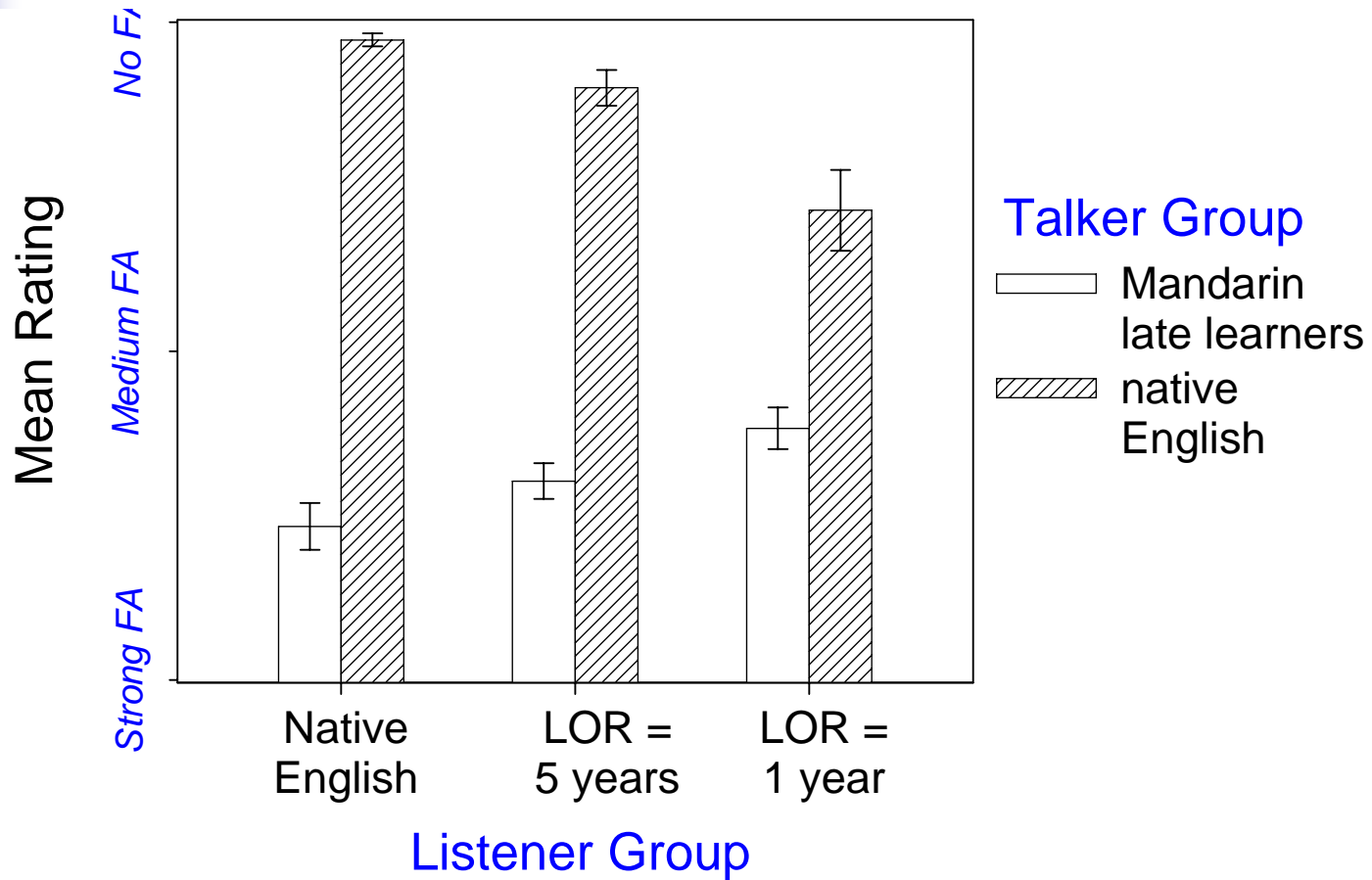
- Examined FA in English sentences spoken by native speakers of English and Mandarin adults
- Sentences rated for FA by three groups of listeners:

Native English

Native Taiwanese, LOR = 1 year

Native Taiwanese, LOR = 5 years

Flege (1988)





Scaling FA

6. **Control for listener variability**
 - ❖ “Talker” analysis: average rating for each talker based on ratings given by multiple listeners
 - ❖ “Listener” analysis: average rating for each listener based on ratings given to all talkers in each group



Scaling FA

7. Use rating scale with sufficient resolution
 - ❖ Southwood & Flege (1999) provided evidence that FA is a metathetic continuum amenable to scaling using an EAI scale;
 - ❖ a 7-point scale may be insufficient (9-point or continuous may be better)



Scaling FA: reliability

- Reliability refers to the “degree to which test scores are free from errors of measurement” (Committee to Develop Standards for Educational and Psychological Testing, 1985).
- Evidence of measurement error: difference in FA ratings when there is little likelihood that FA should have changed (Elliott, 1995).



Scaling FA: reliability

- Flege & MacKay (cited by Piske et al. 2001) recorded 62 Italian-English bilinguals at 2 times separated by 4 years
- No reason to expect a FA difference between Time 1 (1992) and Time 2 (1996)
 - ❖ The bilinguals had lived in Canada for 32 years at T1
 - ❖ They used Italian about the same amount at T1 and T2 (22% vs. 24%)



4. Who has a FA?



Who has a FA?

Many variables influence FA (see, e.g., Flege, 1998, and Piske et al., 2001), including:

- ❑ *Age at first exposure to the L2*
- ❑ *Years of L2 use*
- ❑ *Amount of L2 and L1 use*
- ❑ *Type of L2 input (native speaker vs. foreign-accented non-native speakers)*
- ❑ *Motivation (?)*
- ❑ *Gender (?)*



Who has a FA: Age

Chronological age (CA) of first extensive exposure to an L2 is related to other factors likely to influence L2 speech learning, including

- ❑ *State of neurological development*
- ❑ *State of development of the L1 phonetic system*
- ❑ *Kind/quality of L2 input*
- ❑ *Motivation*



Who has a FA? Child L2 learners

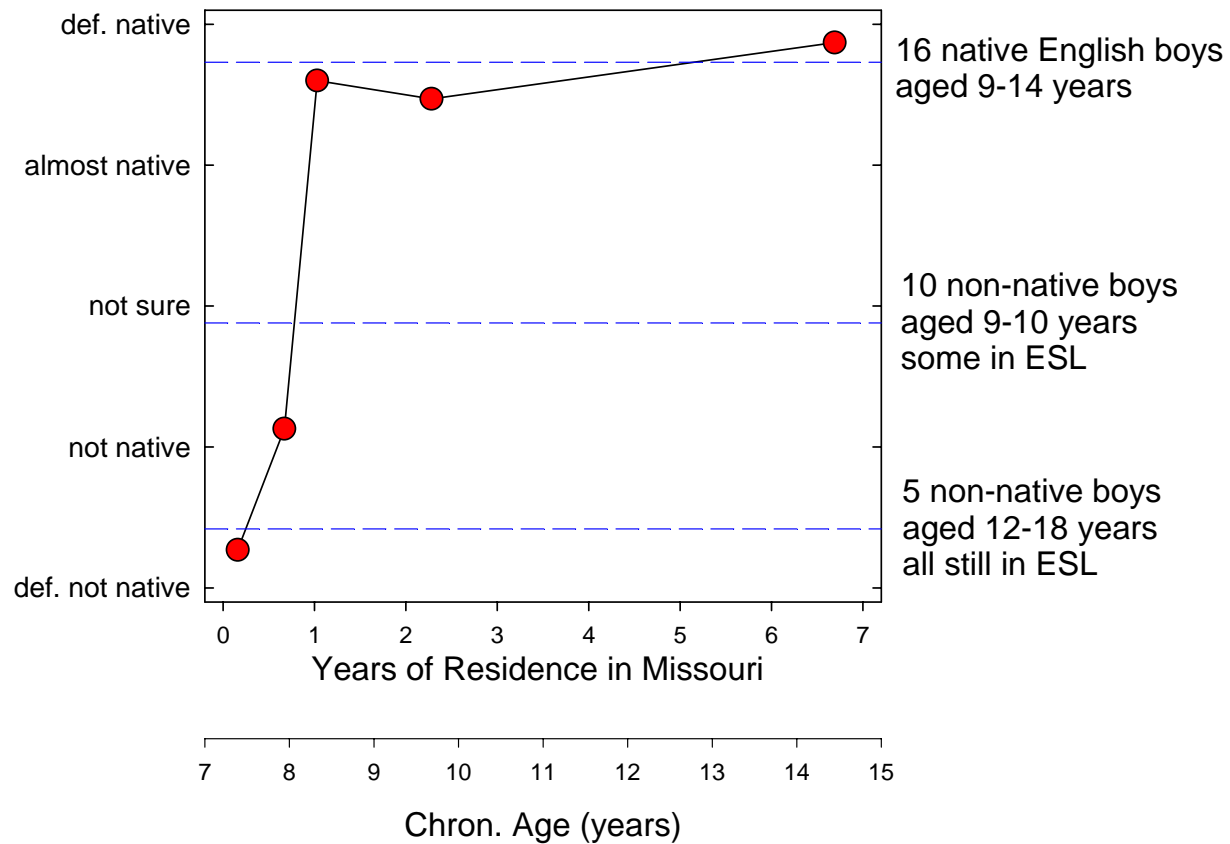
- As discussed by Snow (1987, p. 192), there is widespread belief that children who learn a second language (L2) do so *"quickly, automatically, effortlessly, and to a level indistinguishable from that of native speakers"*
- However, relatively few studies have directly compared adult and child L2 learners



Winitz et al. (1995)

- Supported the view that children learn L2 pronunciation rapidly and accurately
- Longitudinal study of a Polish boy who arrived in the United States at the age of 7 years
- Recorded over a 7-year period

FA ratings for Polish boy





Child L2 learners

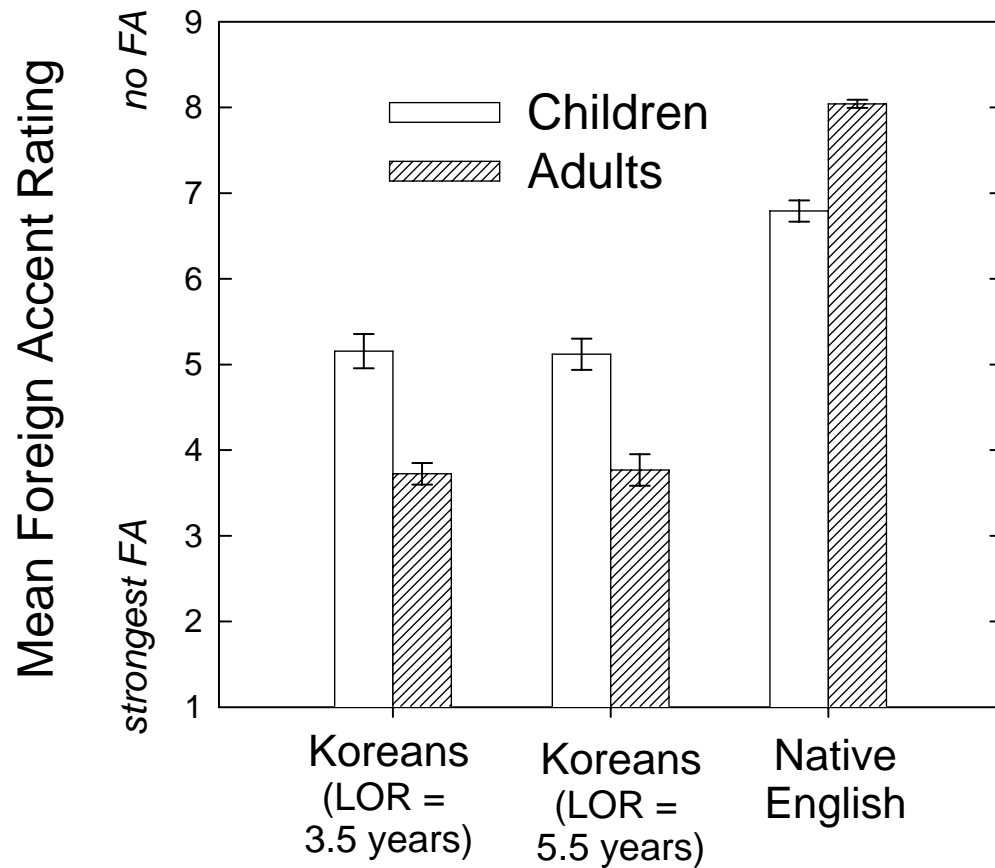
- Results may not generalize to other immigrant children learning English in the US (The boy may have received little or no foreign-accented input)
- Two recent studies examining immigrant adults and children showed that children make more progress than adults, but may retain a FA
 - Aoyama & Flege (unpubl.)
 - Flege et al. (unpubl.)



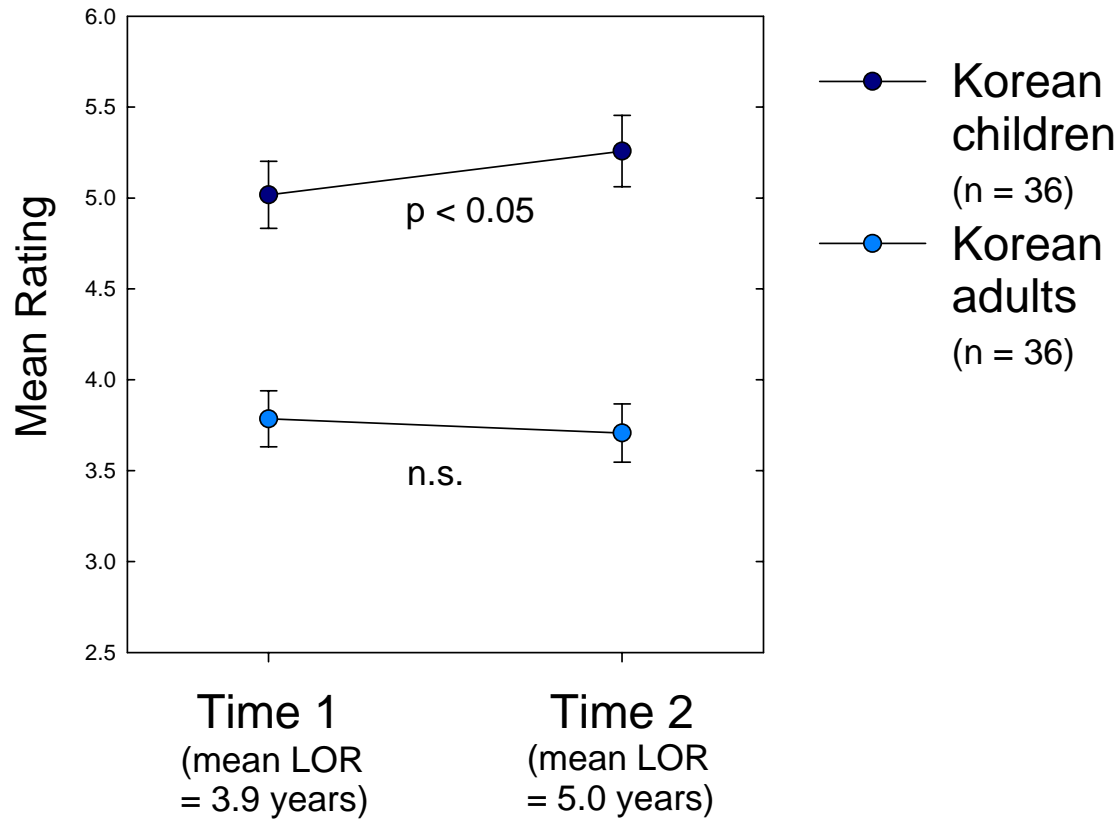
Korean study (Flege et al., unpubl.)

- Examined native Korean (NK) children and adults
- NK participants compared to age-matched native English speakers
- All groups tested at 2 times separated by 1 year

FA ratings averaged over T1 and T2



FA averaged over the Korean LOR groups



Child L2 learners



- Children seem to learn L2 pronunciation faster/better than adults
- However, they are likely to retain a FA, even after 5 years of daily L2 use
- This conclusion may hold true only for child L2 learners who continue using the L1 often and hear the L2 spoken with a FA by others
- Do typical immigrant children retain a FA indefinitely?

Retrospective Developmental Designs



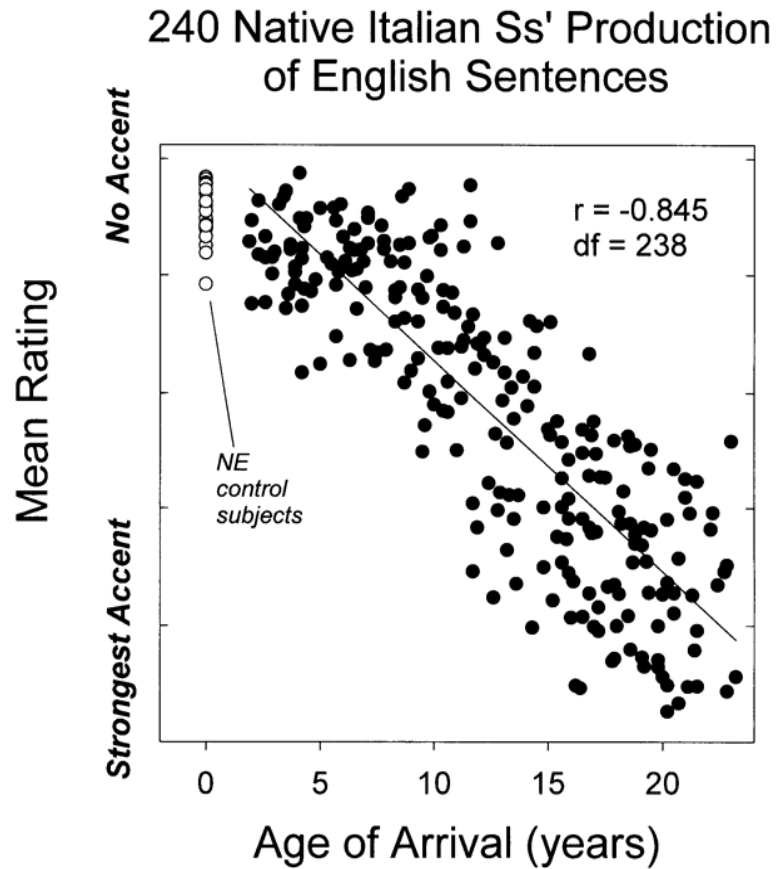
- Two studies each examined large number ($n = 240$) of immigrants to North America
- One study examined Italians in Canada, the other Koreans in the US
- All participants were adults who differed according to age of arrival
- Long residence in North America (mean = 32 years for Italians, 15 years for Koreans)



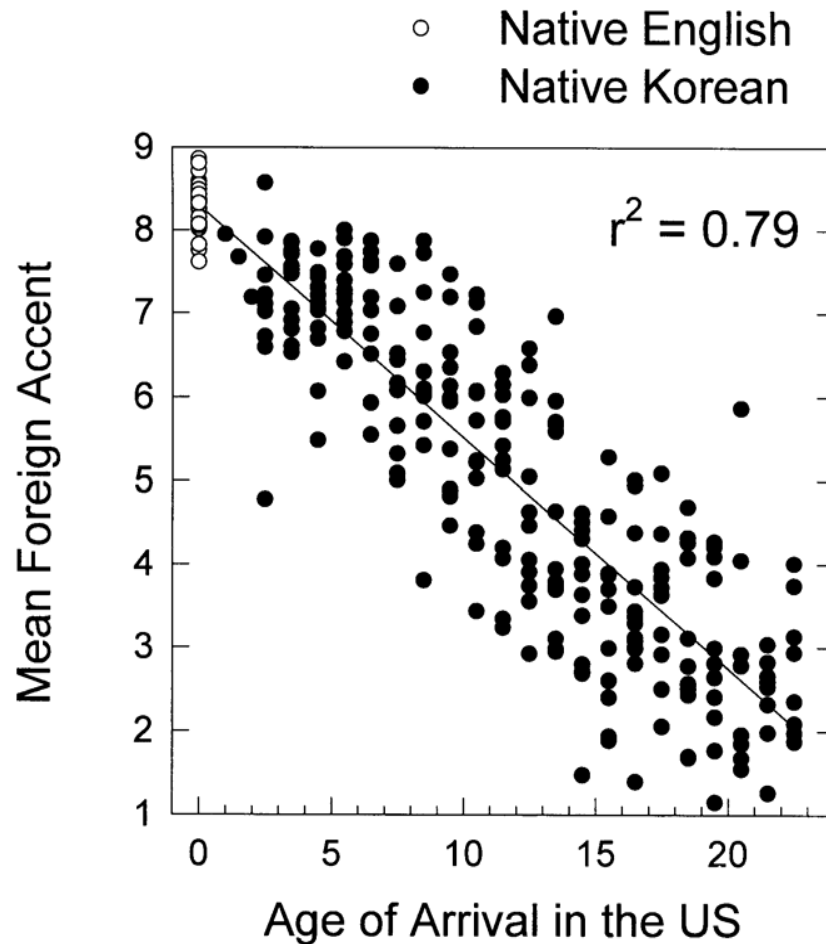
Question addressed

- Would there be a sharp increase in strength of FAs at an AOA of 12 or 13 years?
- Would all late learners have detectable FAs?
- Would all early learners evade detection as foreign-accented?

Italian-accented English (Flege et al. 1995)



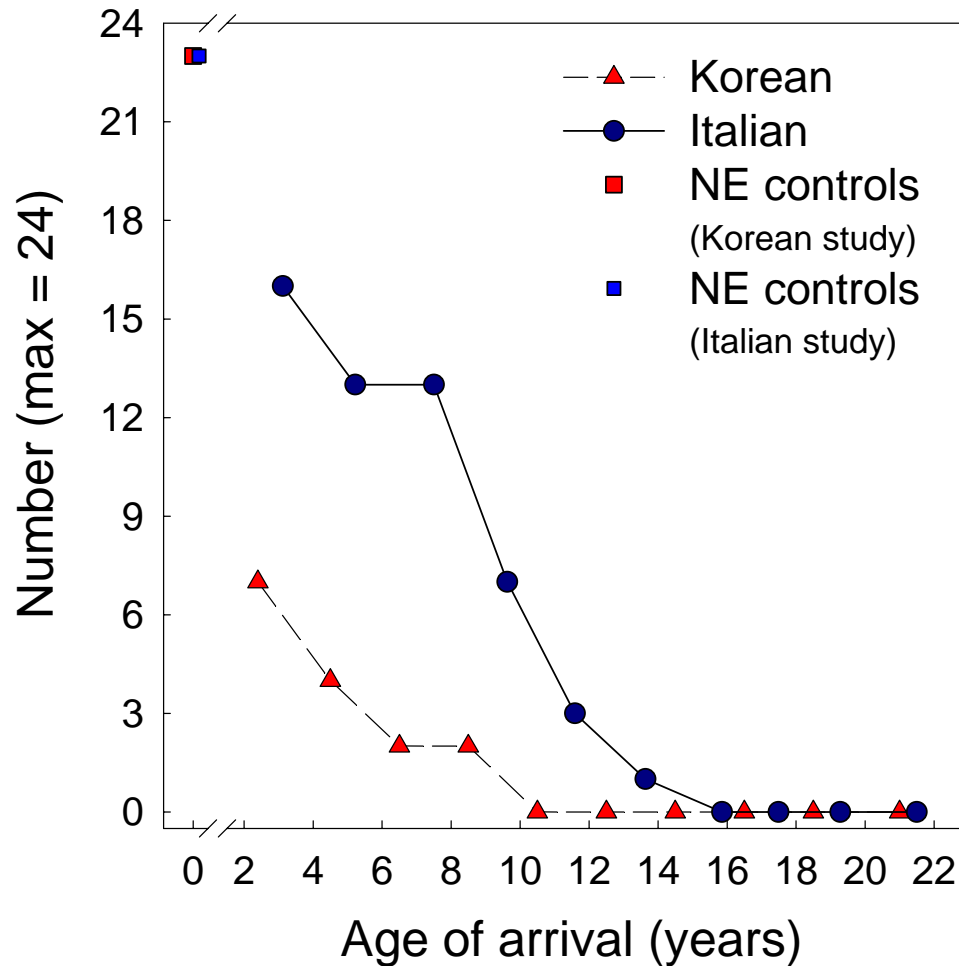
Korean-accented English (Flege et al., 1999)



Who speaks without FA?

- Determine if each Italian or Korean received a FA rating that fell within 2 standard deviations (SDs) of the mean rating obtained for the native English group ($n = 24$)
- In both studies, non-natives assigned to one of 10 subgroups based on AOA (24/subgroup)
- Determine how many non-native subjects in each AOA group met the 2-SD criterion

N of subjects per group (max = 24) without a FA





Retrospective Designs: Conclusions

- No evidence of a non-linearity in the AOA-foreign accent function for either group
- Virtually all participants with AOA > 15 years had a detectable FA
- Most early learners had a better pronunciation than most late learners
- However, many participants with AOA < 10 years had a detectable FA

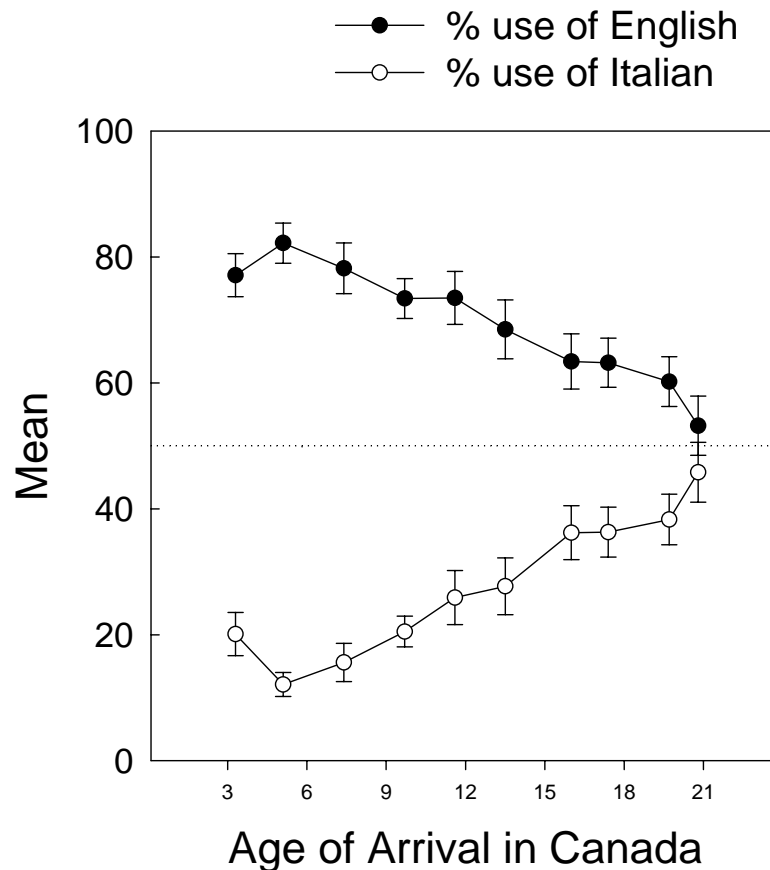
Interpreting age effects ...



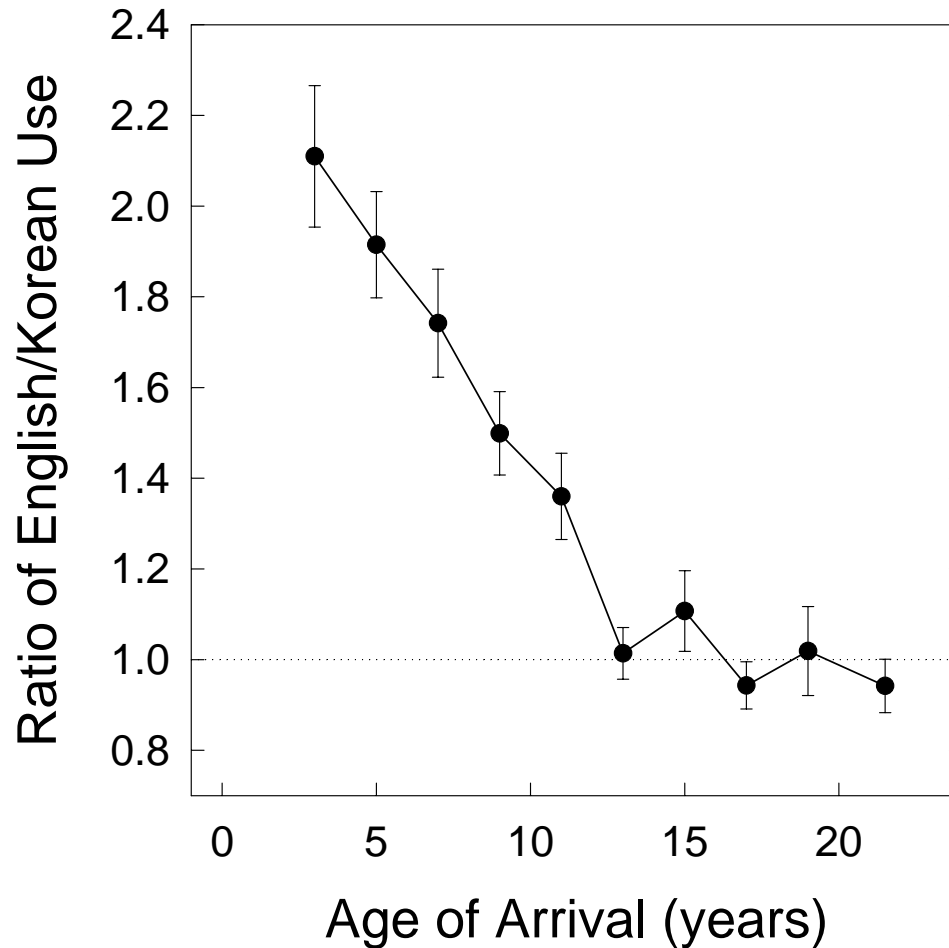
is difficult because AOA is confounded with many factors

- ❑ *LOR* (the longer the better)
- ❑ *Years of education* in US/Canada (the more the better)
- ❑ *English use* (the more then better)
- ❑ *L1 use* (the more the worse)
- ❑ And possibly other things (motivation, amount of foreign-accented input)

Relation between Italian-English bilinguals' L1 & L2 use and AOA



Relation between Korean-English bilinguals' L2/L1 use and AOA

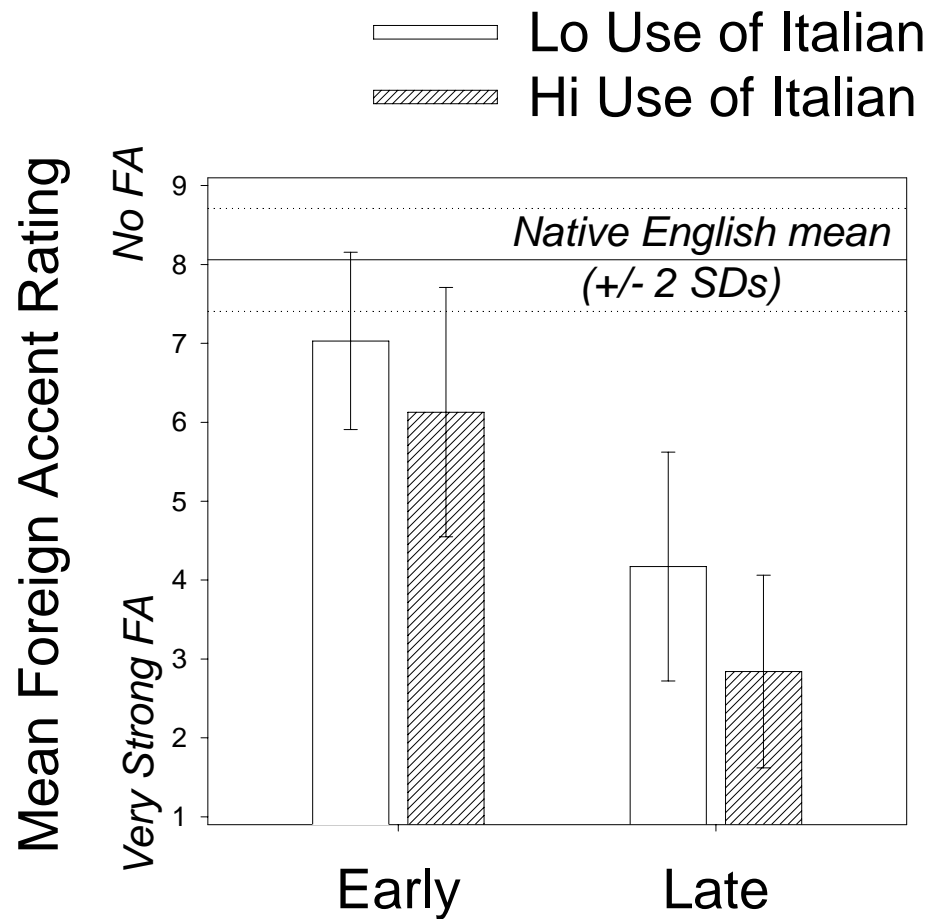




Piske et al. (2001) examined early and late bilinguals who differed in L1 use

	Age of arrival in Canada (years)	% Italian use	Length of residence in Canada
Early-low % Italian use	7	7%	42
Early-high %Italian use	8	43%	40
Late-low % Italian use	20	10%	31
Late-high % Italian use	20	53%	29

Results of Piske et al. (2001)





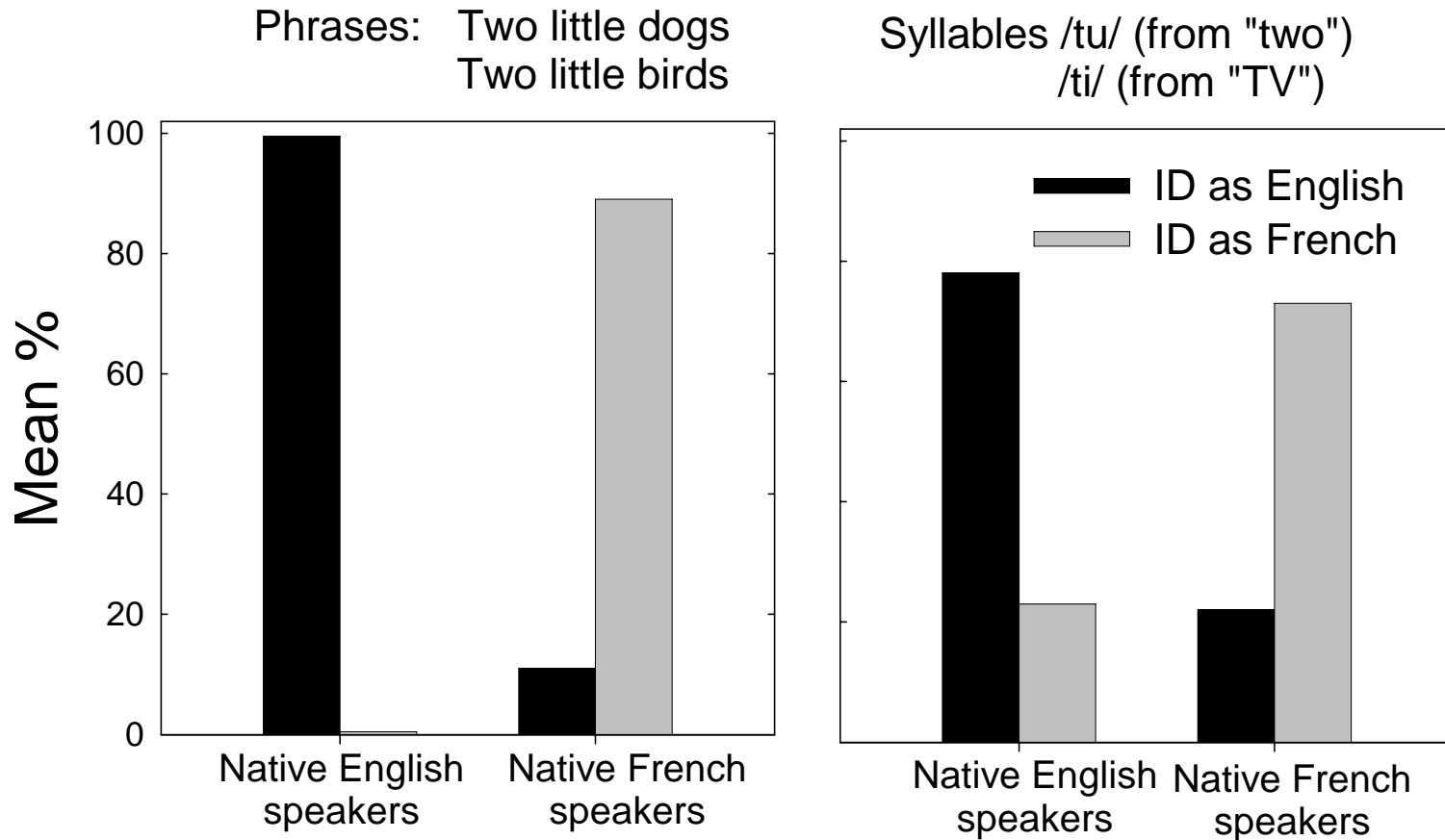
5. Sources of FA



Detection of foreign accent

- Flege (1984) examined the ability of native English listeners to detect French foreign accent
- English phrases and syllables produced by native English and French adults
- Listeners identify speech samples as “English” or “French”

Flege (1984)



Detection of foreign accent



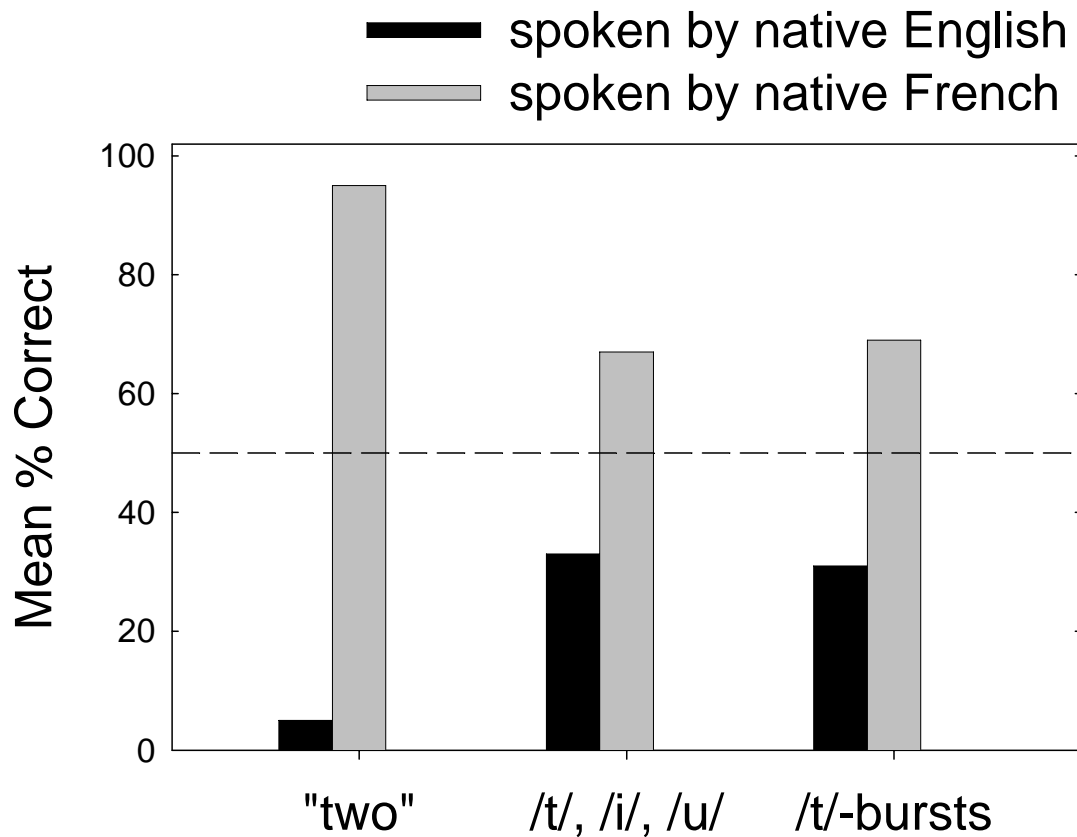
- Flege (1984) examined shorter excerpts of speech in paired comparison experiments
- Two stimuli presented on each trial, one produced by native English talker, the other produced by a native French talker
- Listeners' job: determine which of the 2 stimuli was produced by a non-native (French) speaker

Detection of foreign accent



- Stimuli examined in three experiments
 - The word “two”
 - A single segment (/t/, /i/ or /u/) in cross-spliced CV syllables
 - The first 30 msec of /t/ release bursts
- Correct response rate always exceeded a chance level (50%)

Flege (1984)





Sources of FA: segmental errors

- A number of studies examined the relation between degree of FA and number of overt segmental errors (e.g., Brennan & Brennan, 1981; Major, 1986; Anderson-Hsieh et al., 1992).
- Studies varied according to what kinds of errors were counted (phonemic vs. phonetic; a specified subset of possible errors; just one type)
- However, all showed significant correlations between number of errors and degree of FA

N of segmental errors—FA ratings for 8 non-natives given by naïve listeners, $r = .99$ (C-A & Eng-strand, 1989)

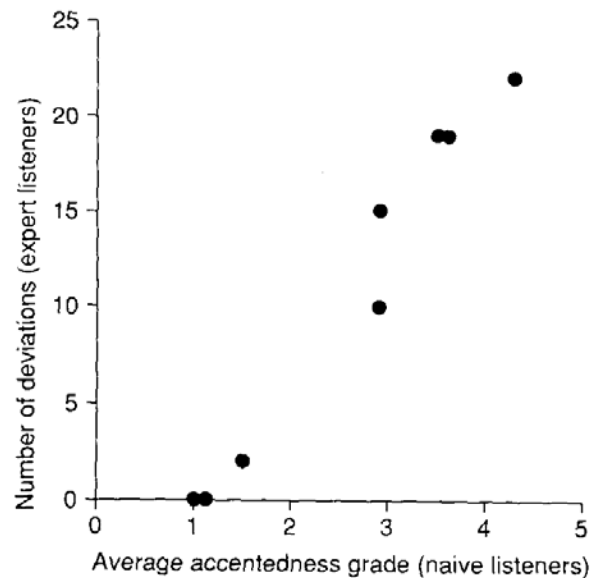


Fig. 1. Relationship between naïve and expert accentedness judgements; the x-axis represents the average grade assigned to the reading by the naïve listeners (1–5), and the y-axis represents the number of deviant pronunciations noted by at least 2 expert listeners for each reading.



Magen (1998)

- Examined English sentences produced by native Spanish adults
- Used editing technique to “fix” particular segmental and prosodic errors
- Presented original and “fixed” sentences to native English listeners
- In many cases, the “fixed” sentences received higher ratings, indicating less FA

Examples of corrections that significantly lessened FA (Magen, 1998)

- “eschool” → “school” (remove epenthetic vowel)
- “plann” → “planned” (insert final /d/)
- “sheep” → “ship” (repair lax vowel)
- “stand” → “stands” (add omitted /z/)
- “chirt” → “shirt” (affricate to fricative)
- lexical stress (ig-NOR-ant → IG-nor-ant)
- phrasal stress (next to HIM → NEXT to him)

Flege and Munro (1994)



- Detailed examination of sources of FA in the word “taco”
- Examined how “taco” was produced by native English speakers and Spanish/English bilinguals
- Began with a cross-language study which compared production of “taco” by Spanish and English monolinguals

Flege & Munro (1994)

	<i>English monolinguals</i>	<i>Spanish monolinguals</i>
<i>a) Voice onset time of /t/</i>	58 ms	18 ms
<i>b) closure duration /k/</i>	73 ms	108 ms
<i>c) duration /o/</i>	149 ms	63 ms
<i>d) intensity /o/</i>	-0.9 dB	-5.3 dB
<i>e) F2 onset /o/</i>	1483 Hz	866 Hz
<i>f) F2 offset /o/</i>	1287 Hz	841 Hz

Flege & Munro (1994)

- Perceptual evaluation of productions of “taco” in English or Spanish by monolinguals
- Also: tokens produced in Spanish and English by early and late Spanish-English bilinguals
- Native English listeners classified the tokens (“Spanish” or “English’) and rated them on a 7-point scale (Spanish to English).




Flege & Munro (1994)

- Detailed acoustic analysis of the “taco” tokens
- Multiple regression analyses examined relation between the acoustic measurements and listener judgments.
- Accounted for 82% of the variance in classifications, 97% of the variance in ratings

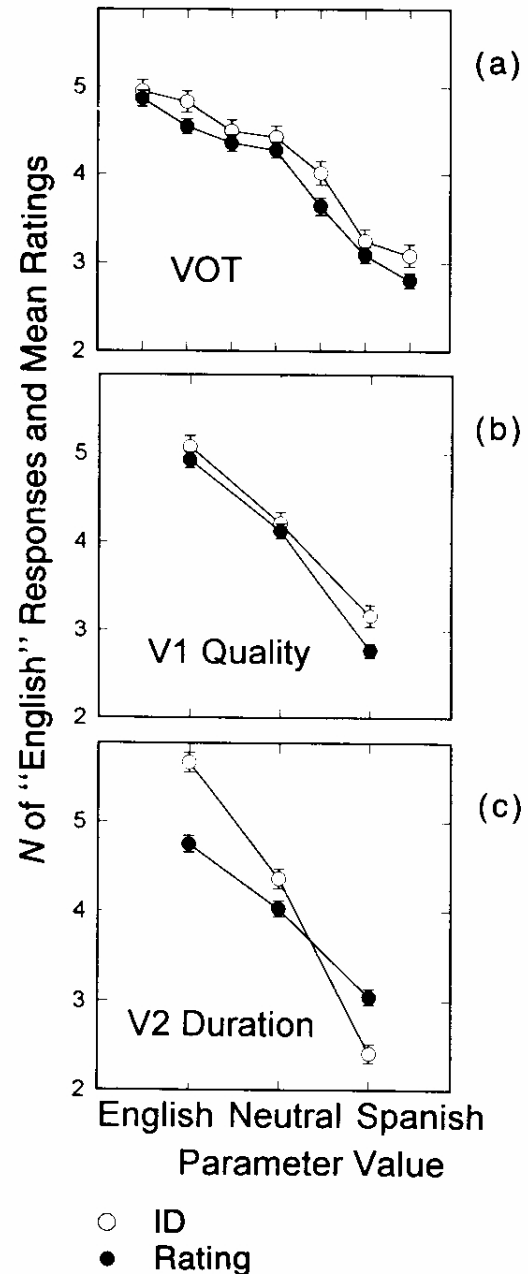


Synthetic speech experiment

- Create Spanish-English “taco” continuum which varied
 - (a) VOT of /t/
 - (b) spectral quality of first vowel
 - (c) duration of the second vowel



Effect of manipulation
of 3 parameters on %
identification as
“English” (or mean
ratings as “English”





Possible prosodic sources of FA

1. incorrect lexical stress and associated difficulty in vowel reduction (e.g., Archibald 1992, 1993a,b,c; Fokes et al. 1984; Adams & Munro 1978; Flege & Bohn 1989)
2. incorrect stressing of function words and other unstressed words and syllables, which contribute to the perception of overall rhythmic differences (Bannert 1984; Adams & Munro 1978)
3. incorrect phrasal accentuation (Levitt 1991)



Possible prosodic sources of FA

4. incorrect pitch accent (Schmid 1986)
5. use of incorrect intonation patterns to mark specific meanings (Grover et al. 1987; Lepetit 1989; Shen 1990)
6. pitch ranges that are either too great or too narrow for the L2 (Backman 1979; Willems 1982; Shen 1989, 1990).



Segments vs. prosody?

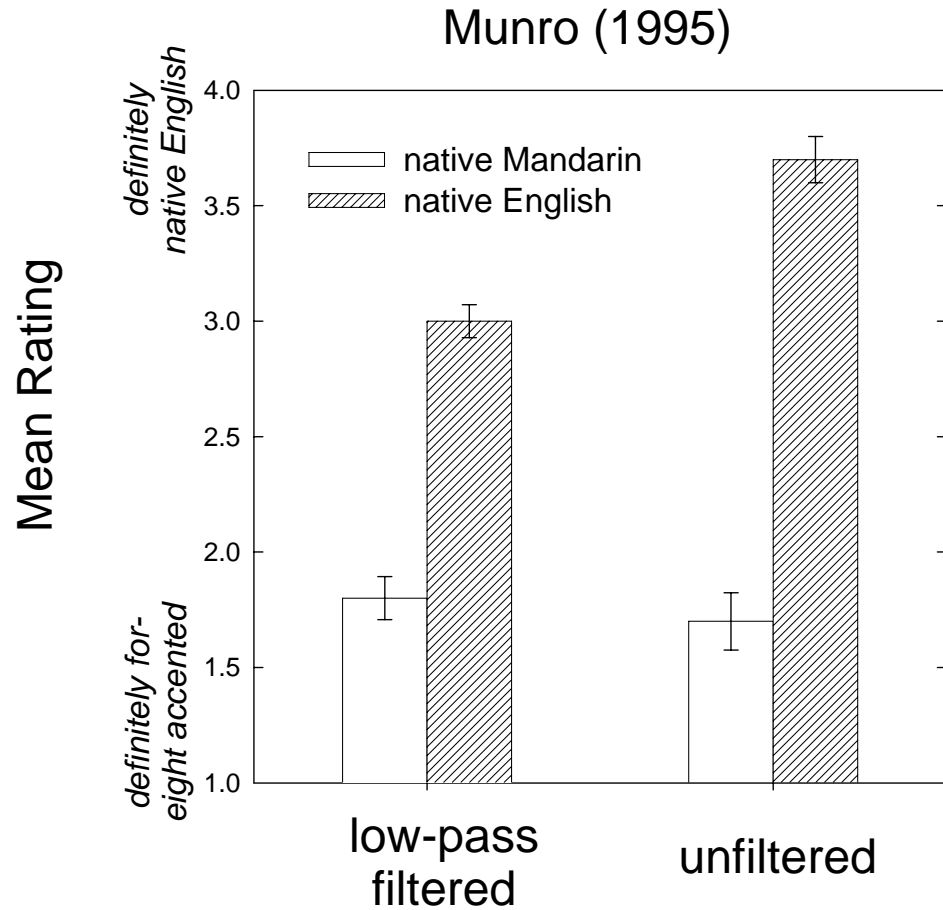
- Anderson-Hsieh et al (1992) obtained global pronunciation ratings of paragraphs read by 60 non-natives.
- Stronger correlation between the global pronunciation ratings and ratings of prosody, $r(58) = .90$, than number of segmental errors, $r(58) = 0.67$.
- Problem: didn't demonstrate that the three trained listeners were able to evaluate prosody independently of segmental errors



Munro (1995)

- English sentences and excerpts of conversational narratives spoken by native speakers of English and Mandarin
- Low-pass filtering (225 or 300 Hz) removed “most” segmental information but left information that specifies prosody (F0, amplitude, duration) intact.
- Materials rated by native English listeners for FA (9- or 4-point scale)

Munro (1995)

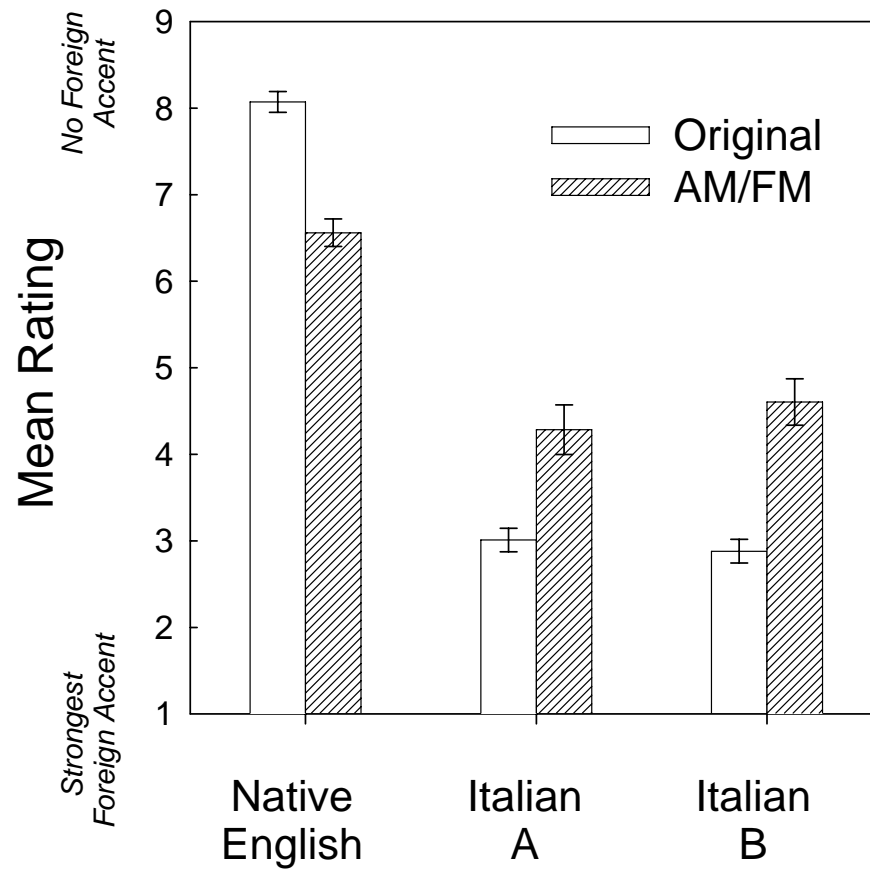


Sources of FA: prosody



- Flege & Hillenbrand (unpubl.) examined English sentences produced by native speakers of English and Italian
- Created “hummed” versions of the sentences
 - Amplitude and F0 extracted every 5 ms; used to modulate a schwa vowel.
 - No trace of trace of segmental information in the “AM/FM” sentences
- Original and AM/FM sentences rated by native English listeners for FA

Flege and Hillenbrand (unpubl.)





Summary

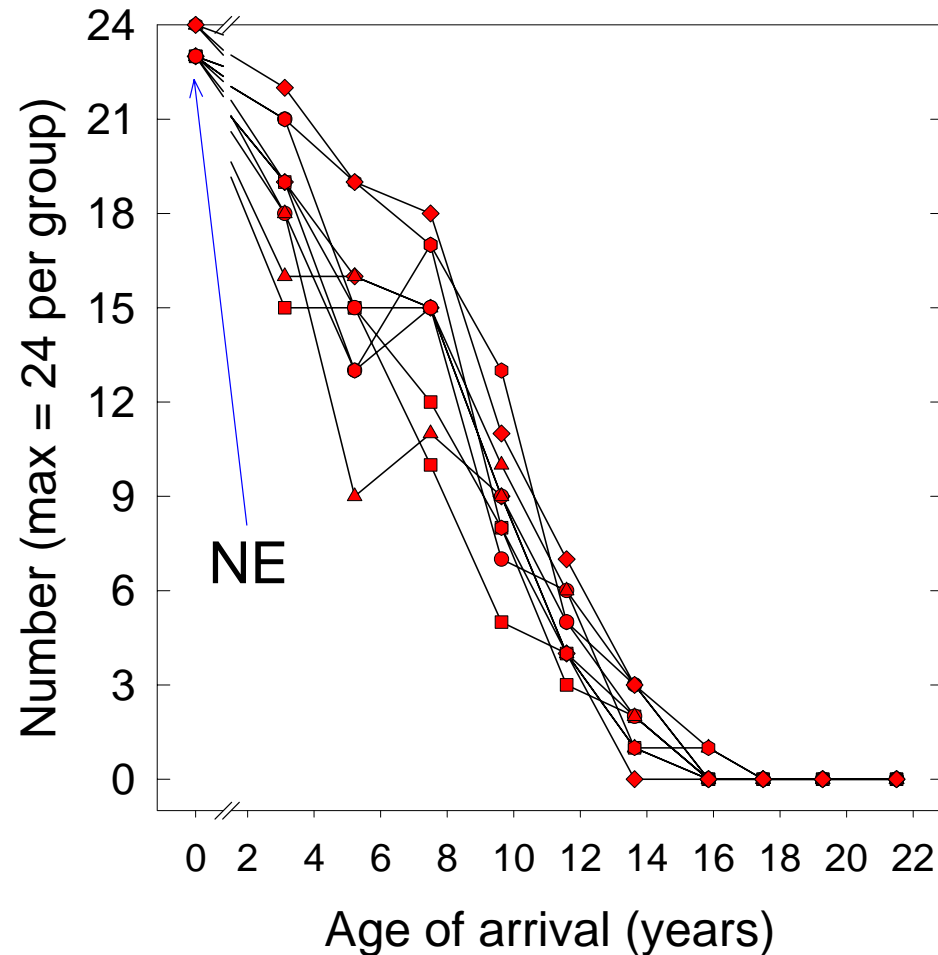
- FA arises from L1-L2 differences
- Certain subject factors (e.g., late exposure) contribute to strong FA
- FA is readily detected by listeners, and may lead to negative evaluation or misunderstanding.
- FA may also lead to slowed processing by native listeners



Summary

- Both segmental and prosodic errors contribute to FA
- Likely that all auditorily detectable divergences from language-specific phonetic norms are used by listeners in gauging FA
- Uncertain at present what aspects of non-native speech are most responsible for the perception of strong foreign accent or slow processing

N of participants without a detectable FA (mean ratings within 2 SD of NE mean)

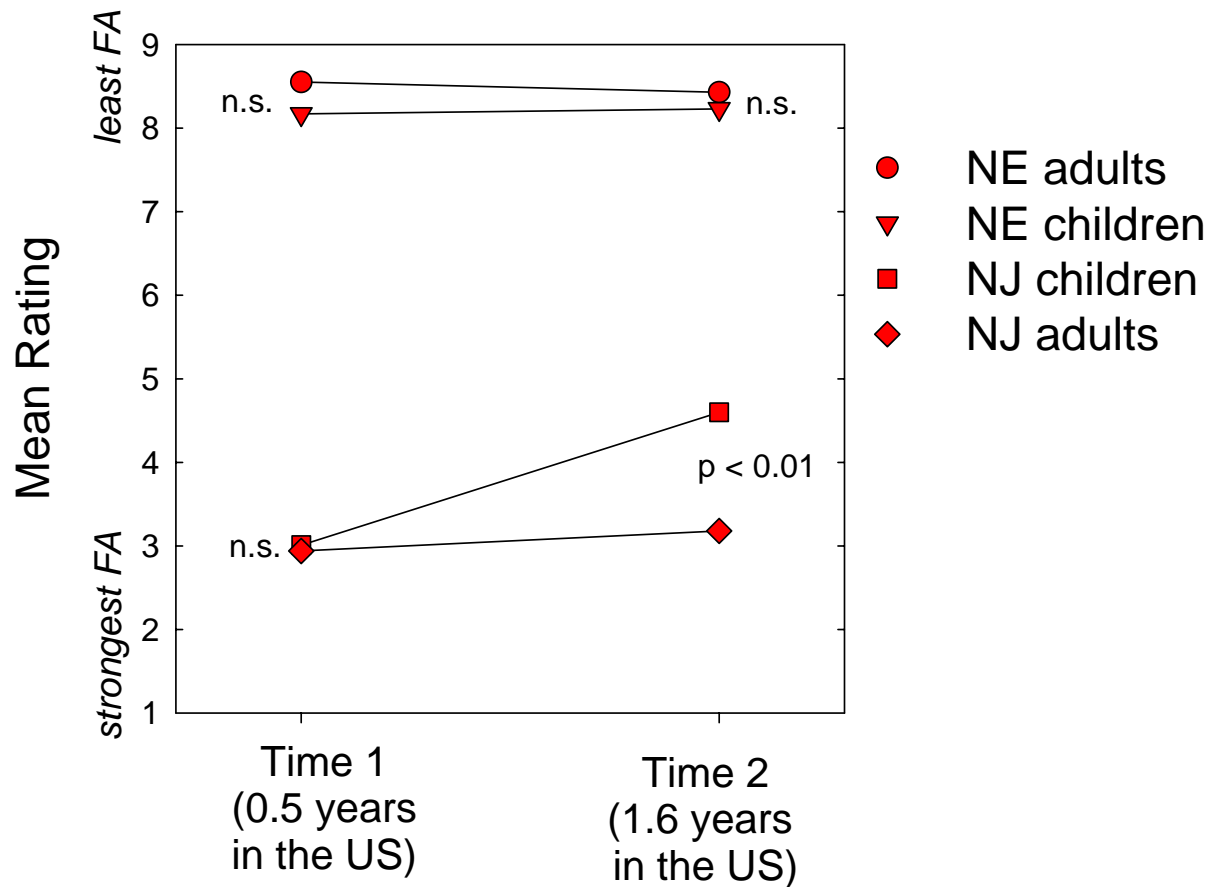


Aoyama & Flege (unpubl.)



- Participants: Native English and native Japanese adults (mean age 40 years); NE and NJ children (mean age 10 years)
- Elicit familiar English words (repeated following an aural model & picture)
- Recorded at 2 times, 1 year apart
- Strings of 4-5 words (e.g., “eight neck read six”) presented to 16 NE listeners for overall rating of pronunciation (9-point scale)
- Median ratings examined in both by-talker and by-listener analyses

Foreign accent results (NJ adults, children)



Confounds with grammatical error in free-speech samples (Derwing & Munro, 2001)

Table 1. Number of listeners' significant correlations of accent features with task scores ($N = 26$)

Accent Feature	Accent Rating	Comprehensibility Rating	Intelligibility Score
Grammar score	13 (50%)	14 (54%)	4 (15%)
Phonemic score	4 (15%)	4 (15%)	2 (8%)
Prosodic score	7 (27%)	9 (35%)	2 (8%)
Speaking rate	6 (23%)	10 (38%)	2 (8%)

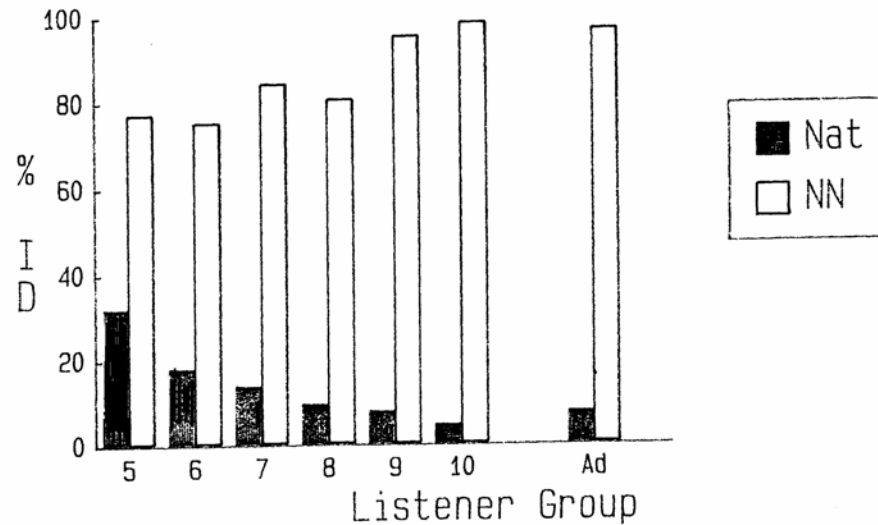
Effects of FA: slowed processing



- Clark (2002) assigned native English listeners to hear unaccented or Spanish-accented renditions of unpredictable SPIN test sentences (e.g., *Ruth must have known about the pie*).
- The final word in each sentence was shown visually immediately after the auditory presentation of each sentence
- Listeners' task: decide if the visual word matched the sentence-final word just heard.
- Responses were significantly longer (ca. 50 ms) for accented than unaccented sentences.

Scovel (1988)

% Identification as "not American"



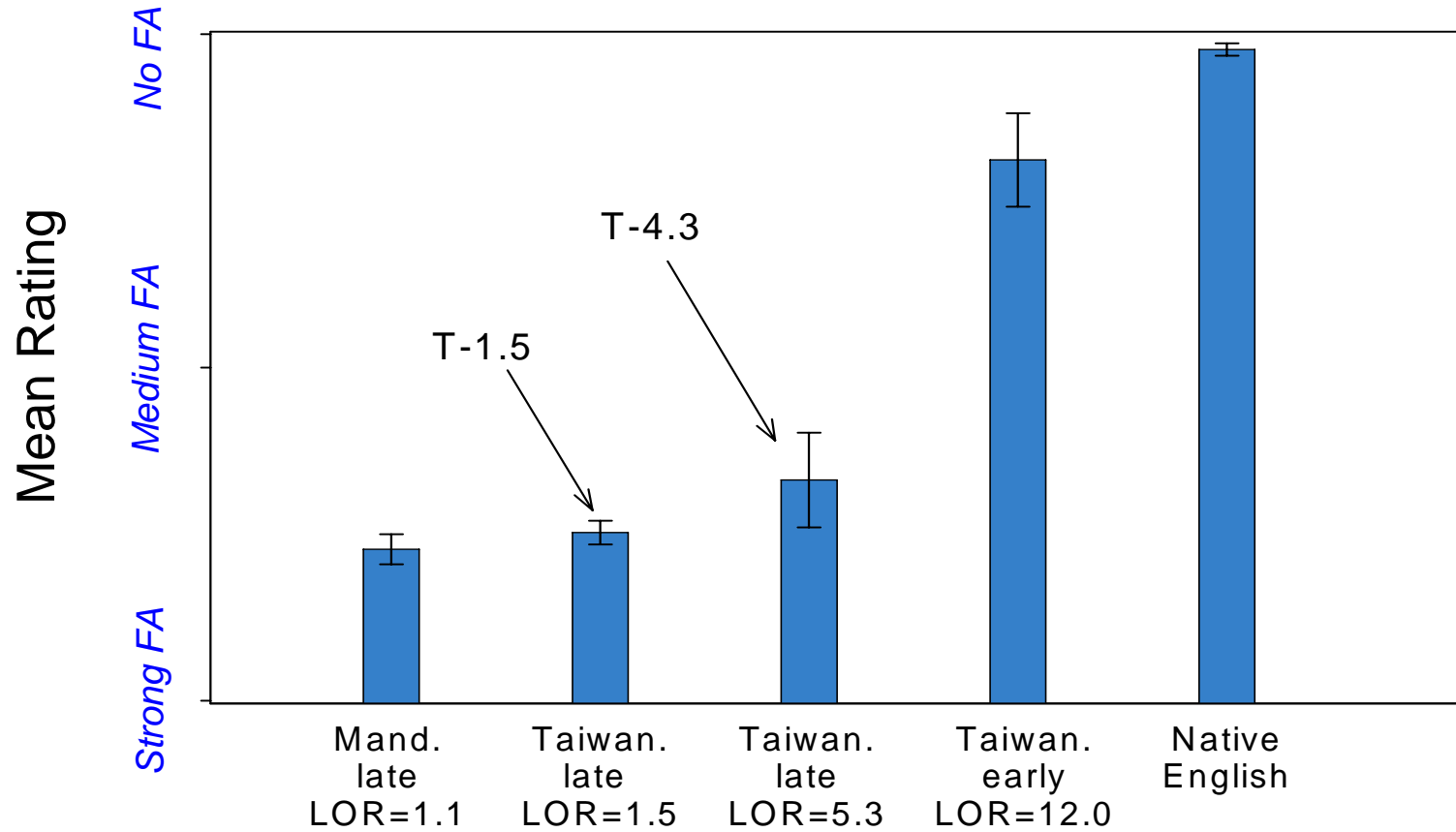


Flege (1988)

Native English (NE) listeners rated sentences spoken by NE speakers and 4 groups of Chinese adults. The Chinese participants differed according to

- ❑ age of arrival in the US (children = “early” learners, adults = “late” learners)
- ❑ native variety of Chinese (Taiwanese, Mandarin)
- ❑ length of residence (LOR in the United States)

Flege (1988)

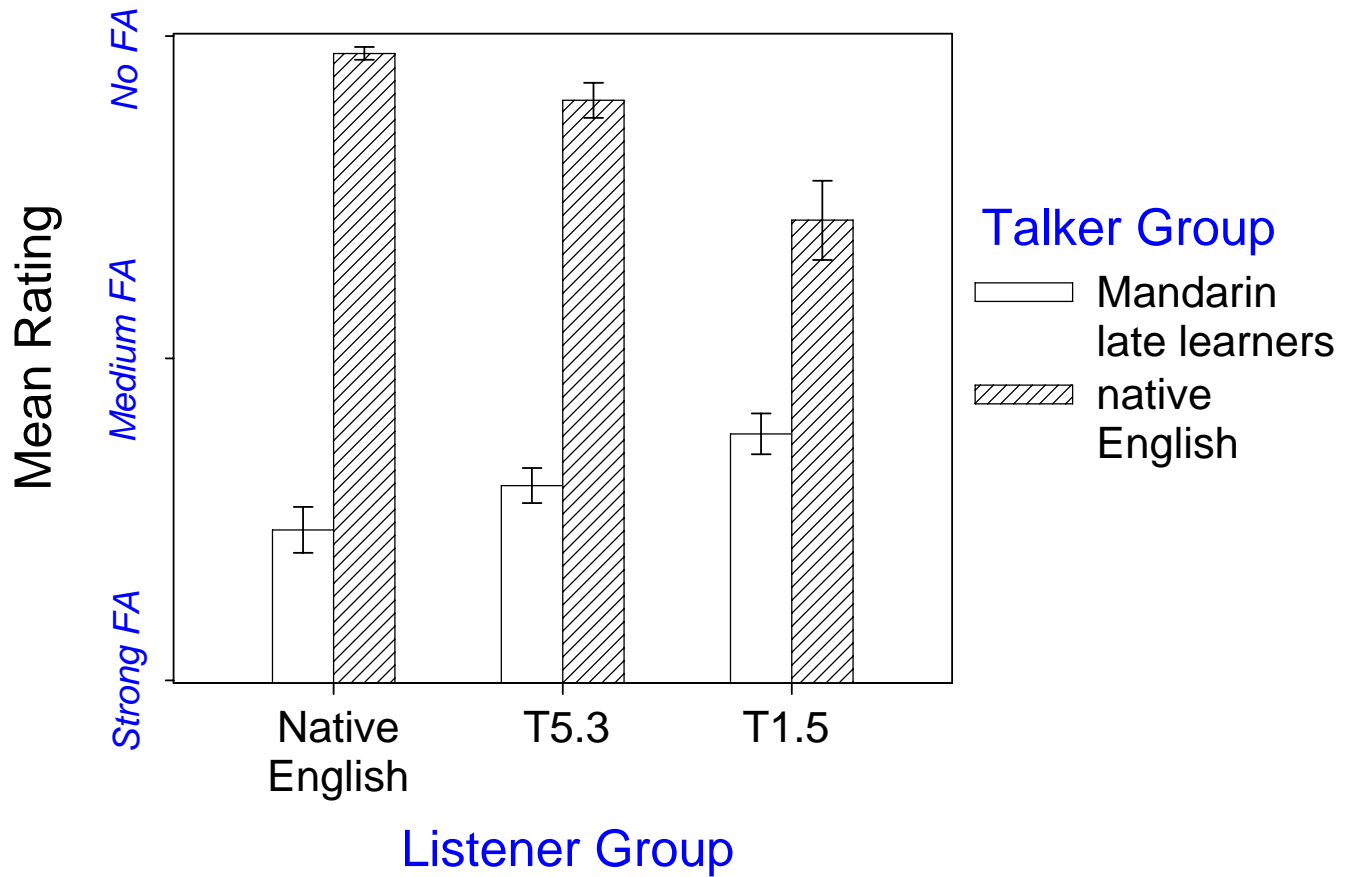




Flege (1988)

- Two groups of Taiwanese late learners differing in LOR rated sentences spoken NE speakers and and Mandarin late learners
- Taiwanese listeners less successful in differentiating sentences produced by native English and Mandarin talkers than native English listeners were

Flege (1988)





FA in early bilinguals

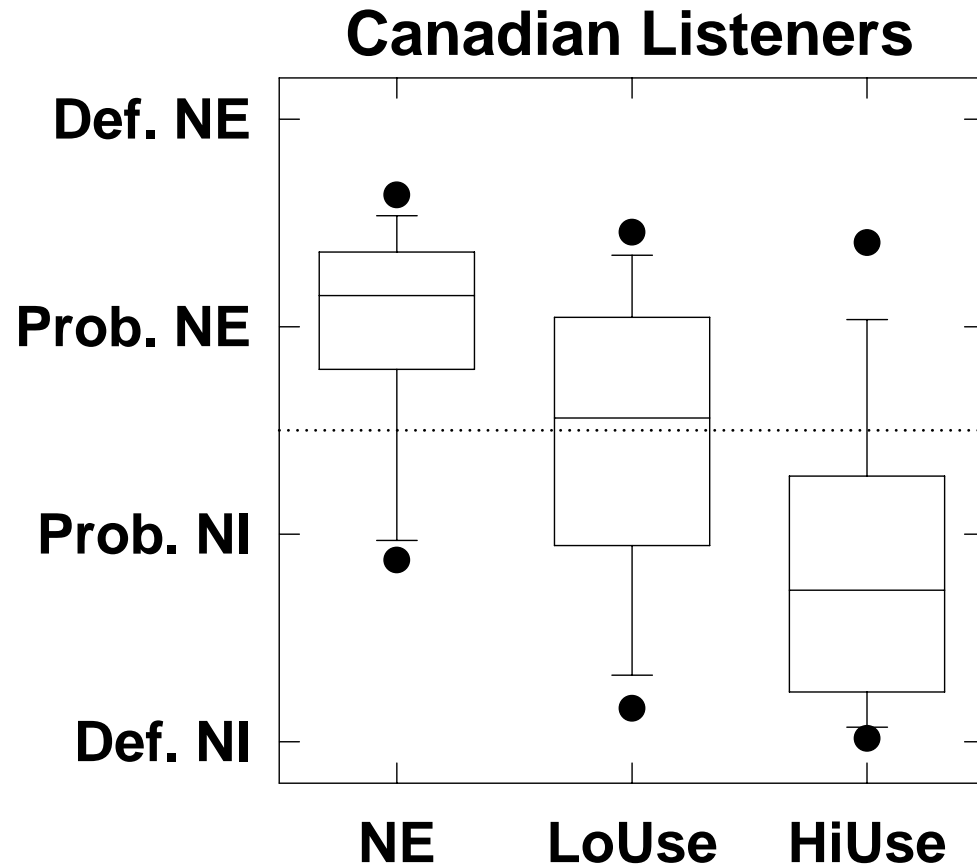
- *Due to the passing of a critical period in early childhood?*
 - Unlikely because L1 speech development is still underway
- *Due to interference from the L1?*
 - If so, may vary as a function of amount of L1 use
- *Several studies have shown that amount of L1 use influences degree of FA*

Effects of L1 use on FA



- Flege et al. (1997) examined early Italian-English bilinguals who differed according to self-reported % Italian use but were matched for AOA (mean = 7 years).
- Sentences spoken by the early bilinguals and NE controls were classified as having been produced by “native” or “non-native” speaker.

FA in early bilinguals (Flege et al., 1997)





Can adults learn speech?

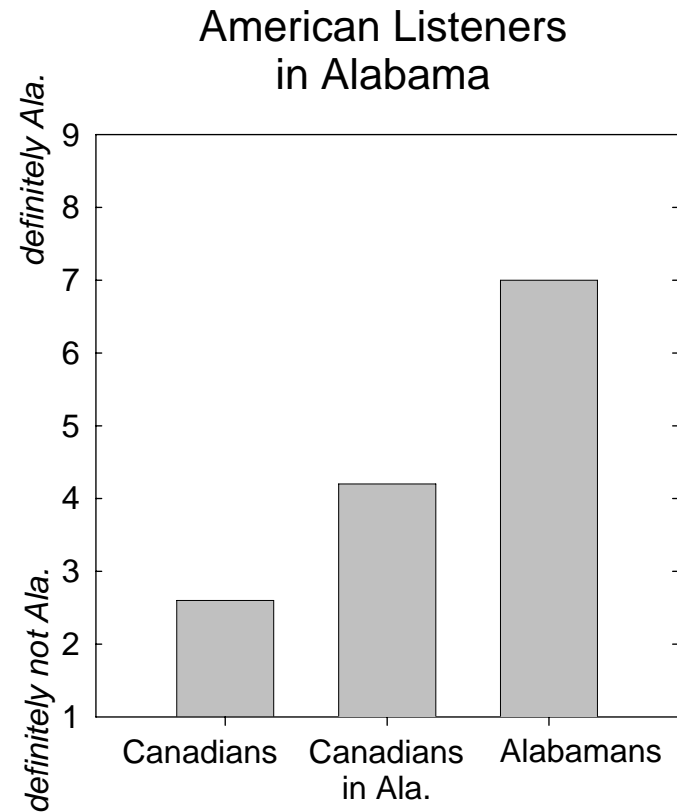
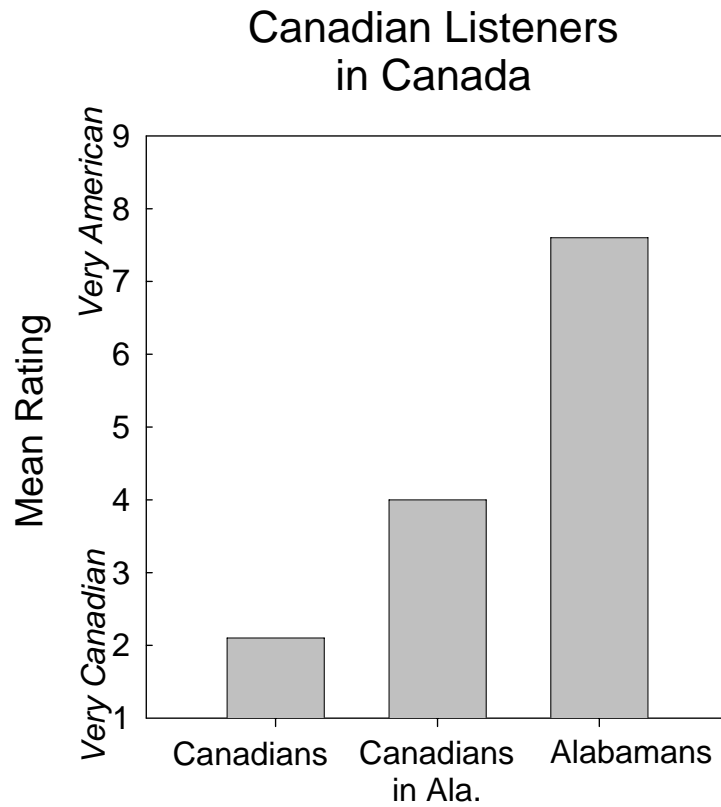
- Children seem to learn more/faster than adults
- Do adults show improvement over time?
- A number of studies have provided evidence of speech learning by adults
- Examples given for cross-dialect learning (Munro et al., 1999) and L2 learning (Flege, 1988; Flege & Fletcher, 1992)



Can adults learn speech?

- Munro et al. (1999) recorded three groups
 - Canadians who moved to Alabama
 - Canadians residing in Canada
 - Native Alabamians
- The native dialect (Canadian) and the “foreign” dialect (that of Alabama) differed only phonetically
- The foreign dialect was not a prestige dialect

Munro, Derwing & Flege (1999)





Adult L2 speech learning

Two studies compared degree of FA in groups of adults differing in length of residence in the US

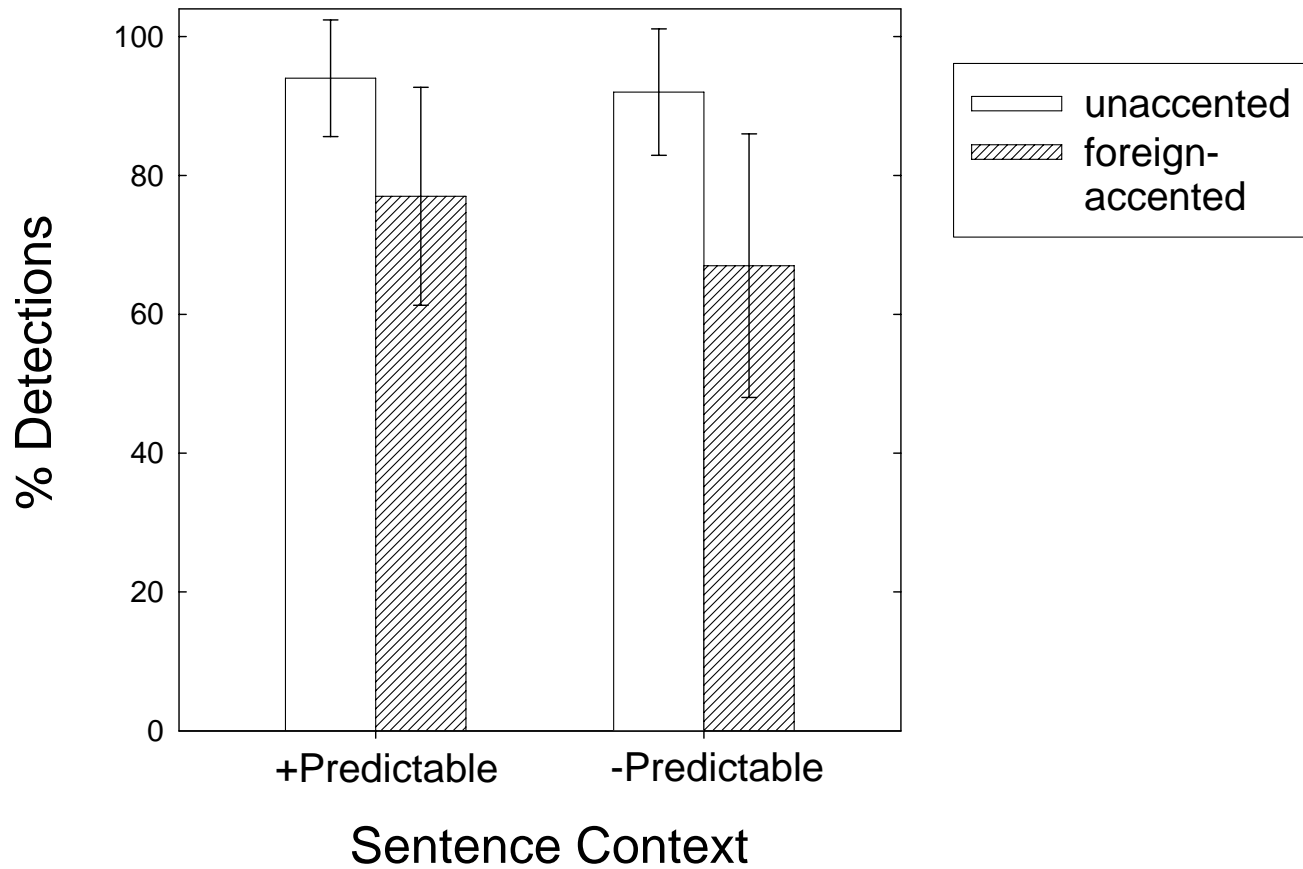
- Flege (1988) compared groups of Chinese adults who had lived in the US for 1.1 and 5.1 years.
- FA of the long-LOR group not significantly better than the shorter-LOR group
- However, a recent study (Flege & Liu, 2001) showed that a 5-year LOR difference was significant only if Chinese immigrants received substantial native-speaker input



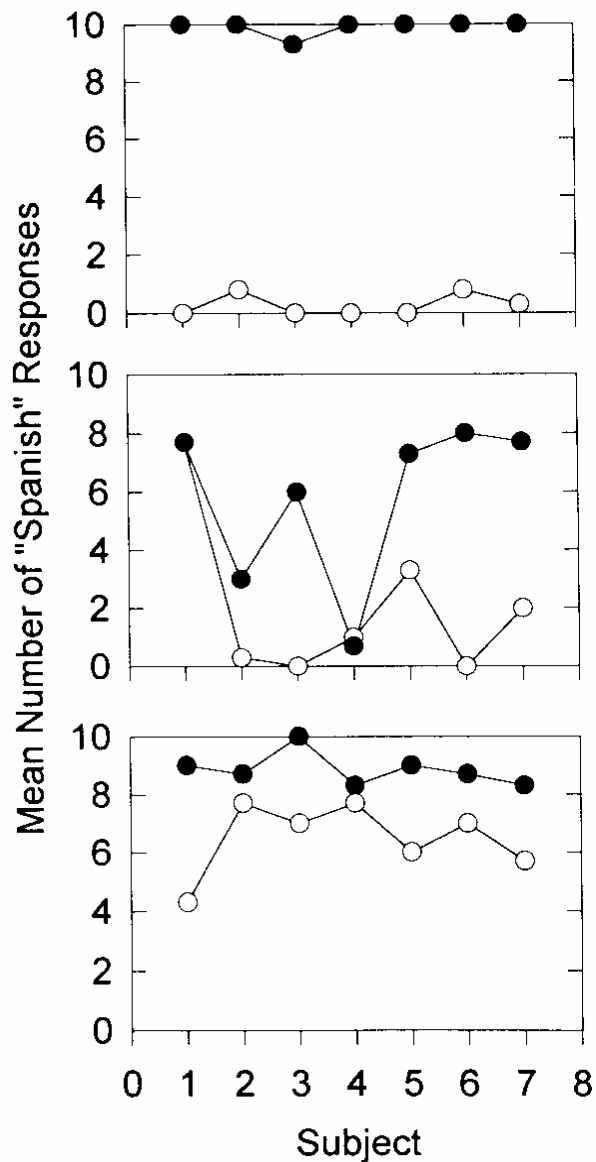
Adult L2 speech learning

- Flege & Fletcher (1992) compared groups of native Spanish adults who had lived in the US for average of 0.7 years and 14.3 years
- Long-LOR group had significantly less FA than shorter-LOR group
- More work needed to determine how much/what kind of L2 input needed for improved L2 speech

Detections of mispronunciations



% ID as Spanish "taco"

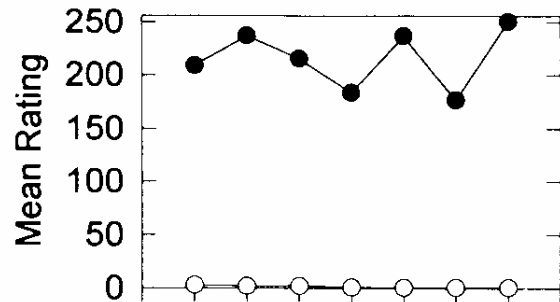


(a) Span. & Eng. mono.

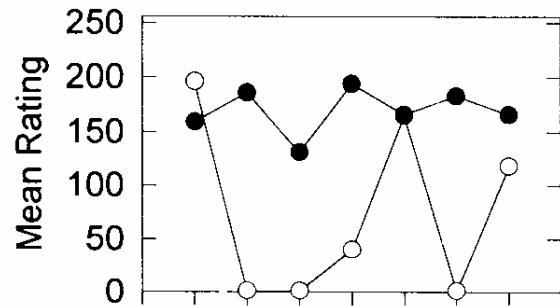
(b) early learners

(c) late learners

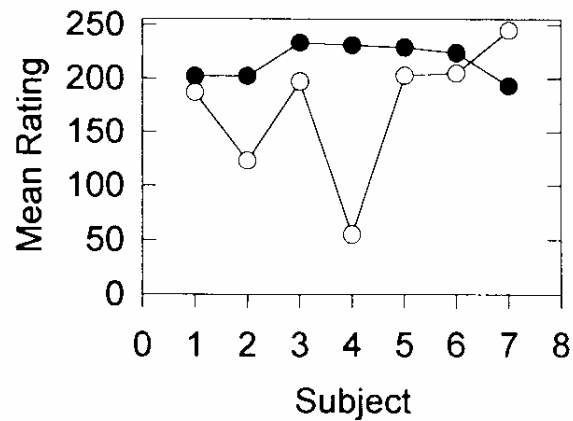
Mean ratings as Spanish “taco”



(a) Span. & Eng. mono.



(b) early learners



(c) late learners

- Spanish *taco*
- English *taco*

Table 4. Summary of forward stepwise regression analyses examining the relation between acoustic variables in *taco* tokens and listeners' perceptual judgments

Step	Variable	Adjusted R^2	Change in R^2	F	P
Mean Identification Scores					
1	VOT of /t/	53.6	—	79.77	.000
2	Vowel 2 duration	64.4	10.8	16.91	.000
3	F2 Vowel 1	68.1	3.7	6.63	.017
4	F2 onset Vowel 2	70.4	2.3	4.43	.047
5	VOT of /t/ REMOVED	—	—	—	—
6	F1 Vowel 1	73.2	2.8	4.19	.053
7	F3 (onset) of Vowel 2	77.8	4.6	6.81	.016
8	F3 (offset) of Vowel 2	80.6	2.8	4.30	.049
Mean Ratings					
1	VOT of /t/	86.6	—	870.45	.000
2	VOT of /k/	89.6	3.0	33.09	.000
3	F3 of Vowel 1	90.9	1.3	14.63	.001
4	F2 (onset) of Vowel 2	92.6	1.7	17.68	.000
5	F1 (offset) of Vowel 2	95.2	2.6	24.00	.000
6	Vowel 2 intensity	96.8	1.6	14.81	.001
7	Vowel 2 duration	97.2	0.4	3.98	.059

Note: The F values are tests of significant R^2 changes using the error term from the final step of the analyses.



Explanations for Age Effects

1. *Maturation constraint*: the capacity for learning speech is reduced as the result of normal neural maturation (e.g., Scovel, (1981, 1988).
2. *Input*: children receive more native-speaker input than adults do
3. *Motivation*: Children are more strongly motivated to learn to pronounce the L2 accurately because they want to “fit in” with their peers.



Explanations for Age Effects

4. *L1 development-A*: Native language production patterns are better established in adults than children, and so are more likely to be maintained in L2 production
5. *L1 development-B*: Native language perception patterns are better established in adults than children, leading to a greater likelihood of misperception (which, in turn leads to production errors)