



Acoustic Expansion of Accented Vowels in American English

Heejin Kim & Jennifer Cole

University of Illinois at Urbana-Champaign

hkim17@uiuc.edu, jscole@uiuc.edu




Prosodic effect on segmental variations

■ Articulatory studies

Beckman and Edwards 1994, Beckman et al 1992, Byrd 2000, Cho 2002, Cho 2001, Cho & Keating 2001, Cho & Jun 2000, Edwards et al 1991, Fougeron 2001, Fougeron & Keating 1997, Keating et al 2003

□ Prosodically prominent positions

- stress, accent, contrastive emphasis, domain-initial/final

- 
- Greater articulatory gestures
 - Bigger
 - Longer
 - Greater peak velocity

 - Reduced coarticulation
 - Fowler 1981, de Jong et al 1993, de Jong 1995, Cho 2004

 - Hyperarticulation De Jong 1995
 - Enhancement of distinctiveness of segments



■ Acoustic studies

□ Increased duration of Cs and Vs

Edwards et al. 1991, Fougeron & Keating 1997, Pierrehumbert & Talkin 1992, Turk & White 1999, Wightman et al 1994

□ Faster rate of spectral change in VC transitions under accent

Wouters & Macon 2002

□ Less V-to-V coarticulation

Cho 1999



□ Sonority expansion vs. hyperarticulation

■ Higher F1 for / a /

Harrington et al. 2000, Erikson, D. 2002, Cho *in press*

■ Contradictory findings on / i /

□ Higher F1 - Sonority expansion

Harrington et al. 2000

□ Lower F1 - Hyperarticulation

Erikson, D. 2002

□ Lower F1 for some speakers, higher for others

Cho *in press*



Prosodically-conditioned acoustic variation

- What is the range of prosodic effects on acoustic variation?
 - What features vary?
 - Any effect on phonological contrast?
 - Any benefit for listeners?
- How much variation occurs in natural speech, outside the laboratory?



In this study

- Topic

- Effect of phrasal accent on vowels in American English

- Research questions

- Contrast enhancement?
 - Backness?
 - Height?
- Sonority enhancement?



Methods

■ Material

□ Boston Radio News corpus

- 4 speakers (F3A, F2B, M1B & M2B) in lab news portion
- 10 minute speech for each speaker

■ Measurements

□ F1 and F2 in Bark

□ Vowel midpoint



■ Target vowels

- 4 vowels /i, a, u, ε/
- Intermediate phrase-medial positions
- Vs followed by [l], [r] are excluded
- # of tokens per speaker
 - 210-270 for accented Vs
 - 170-180 for unaccented Vs, including stressed and unstressed Vs.



■ Analysis

Distributions of vowels

- Discriminant plane of F1 and F2

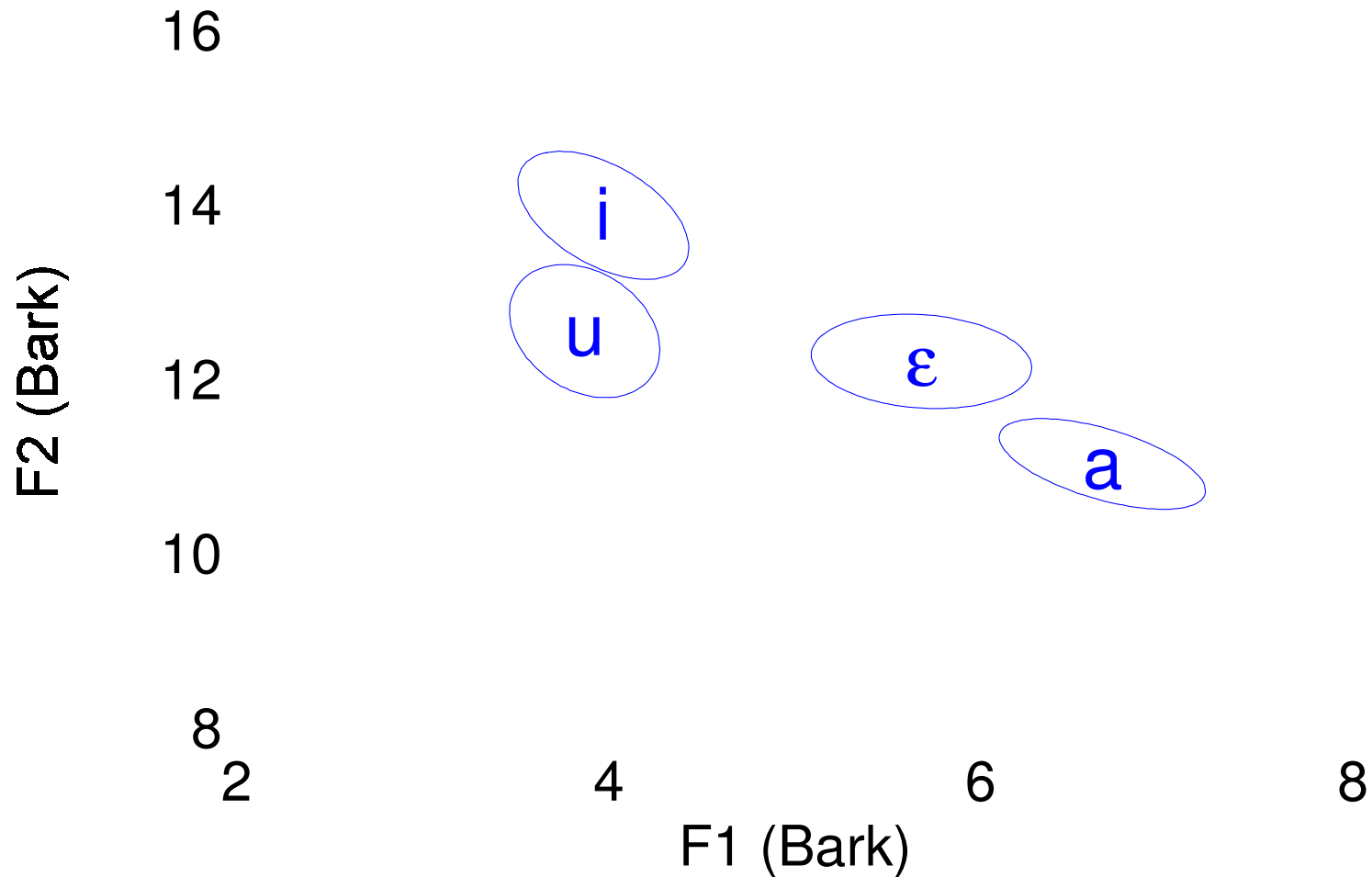
T-test

- Are formants significantly different depending on Accent conditions?

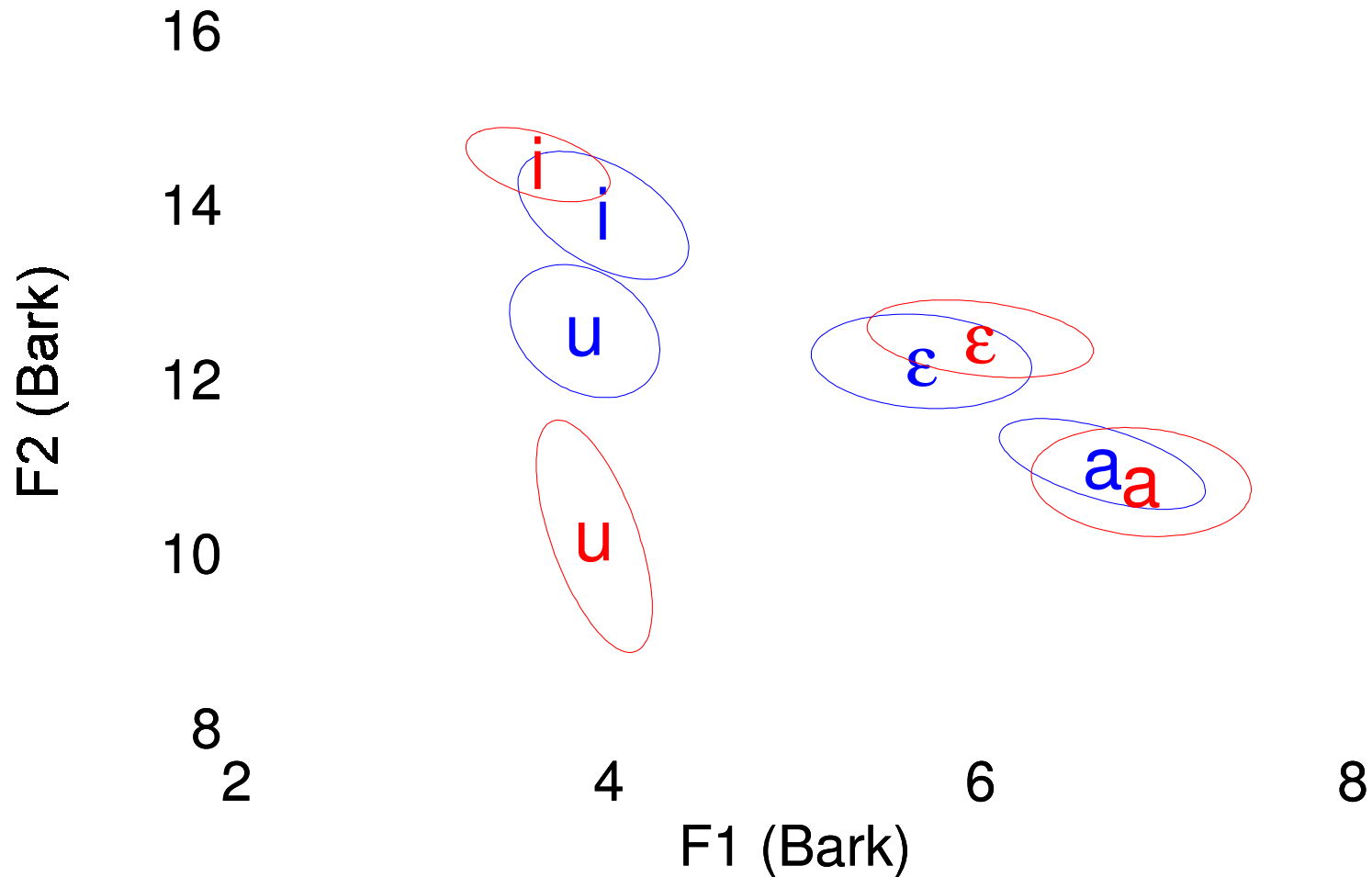


Results

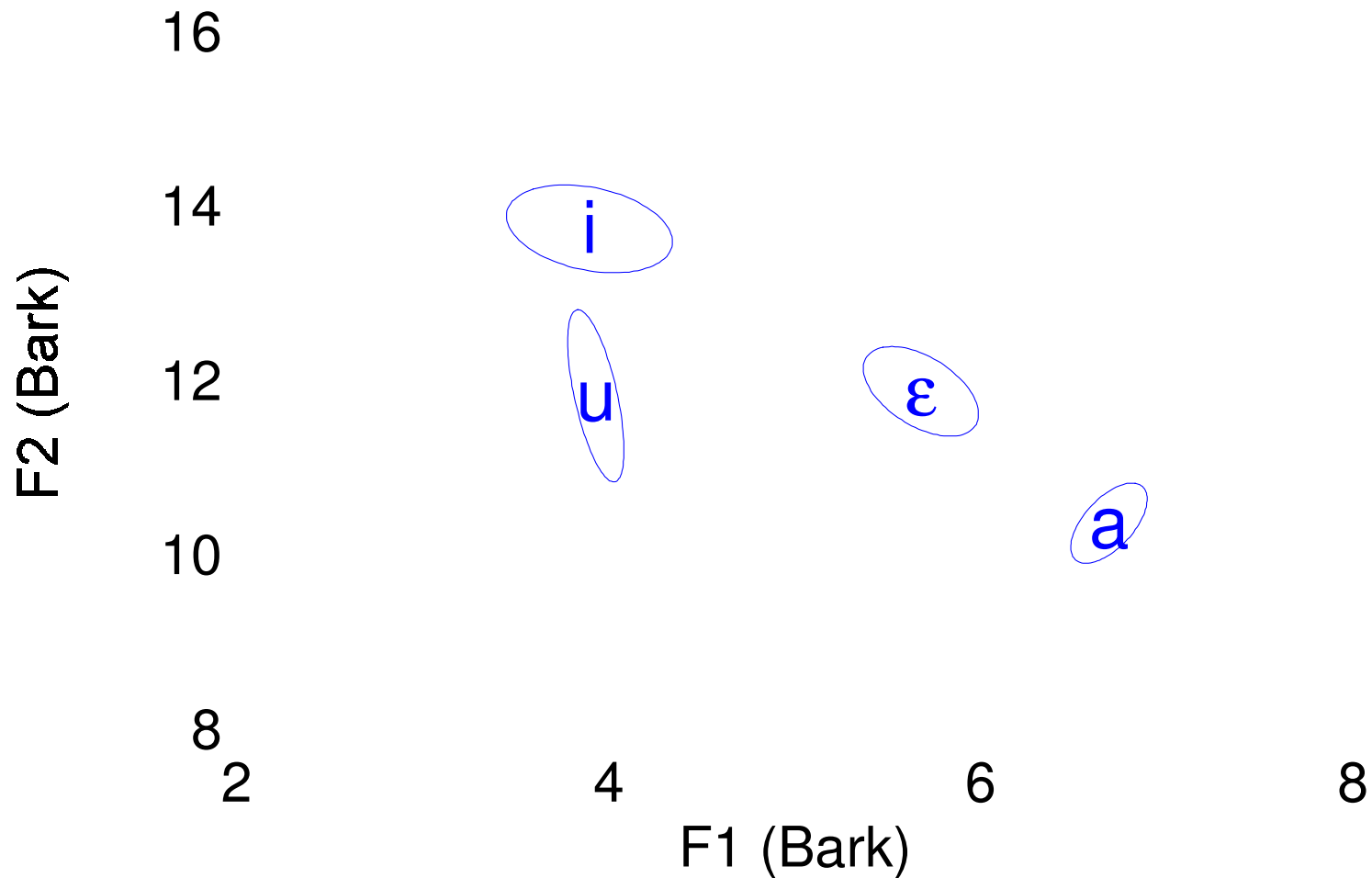
Speaker F3A - unaccented



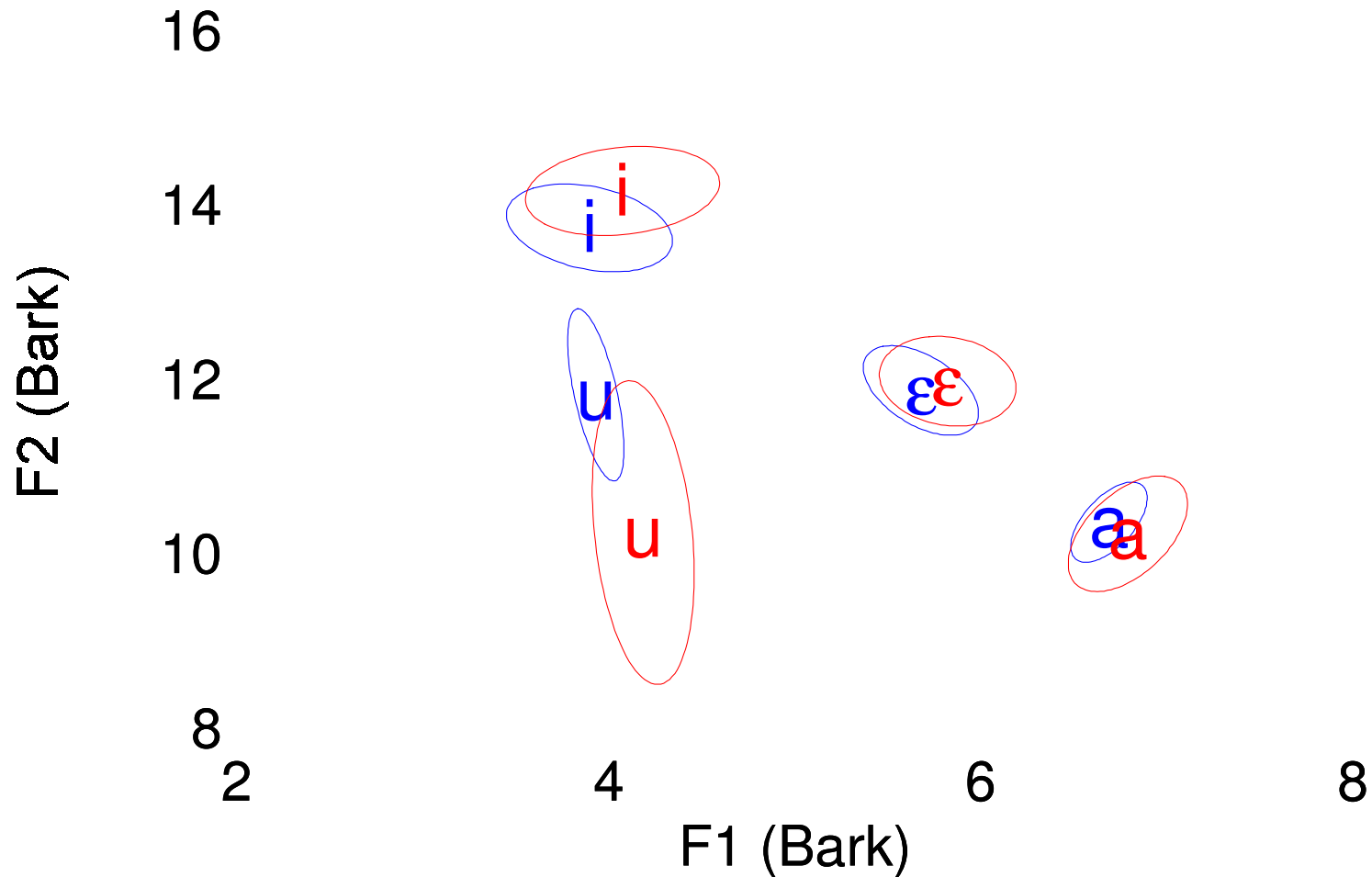
Speaker F3A – Accented in red



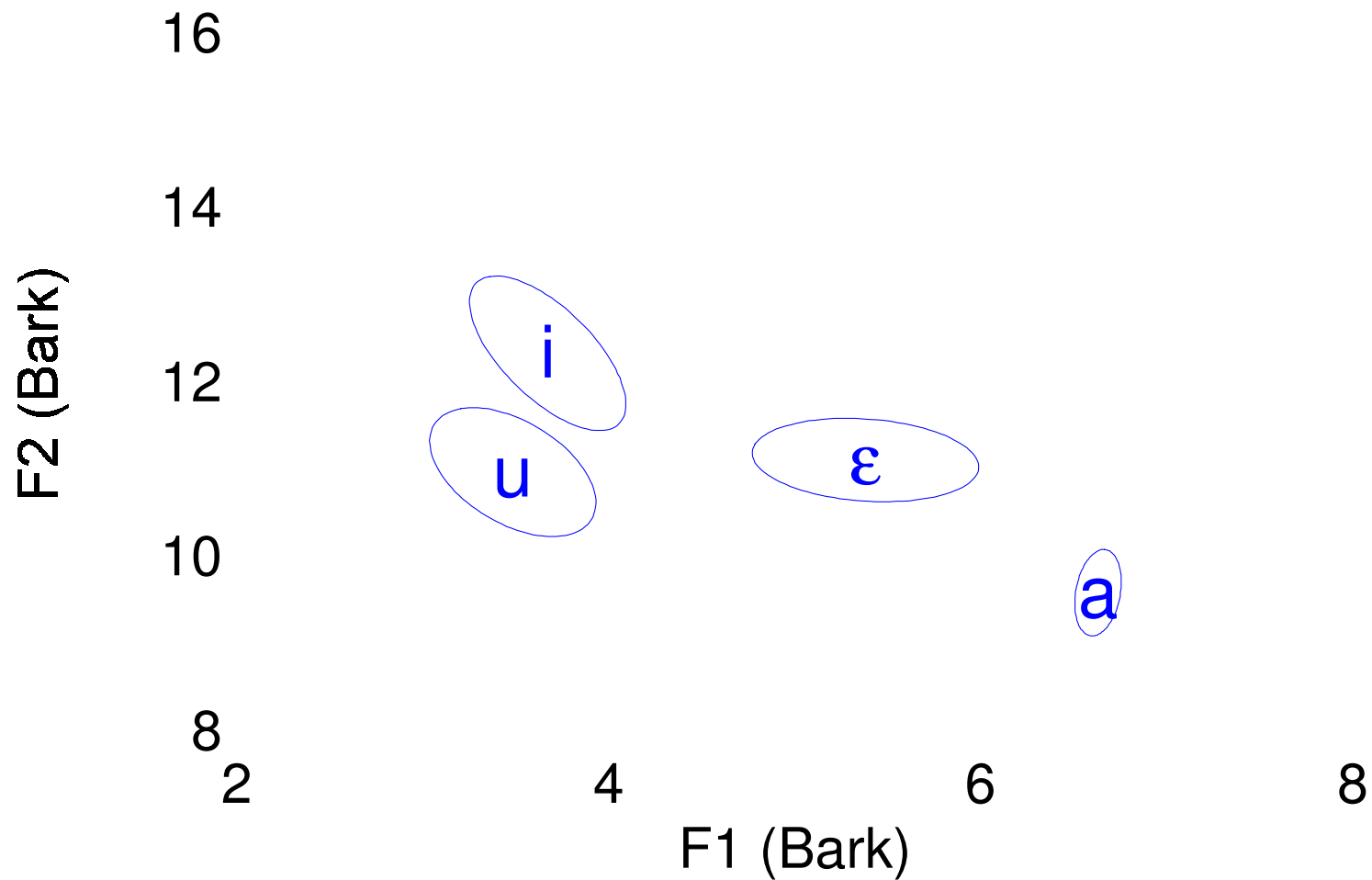
Speaker F2B – unaccented



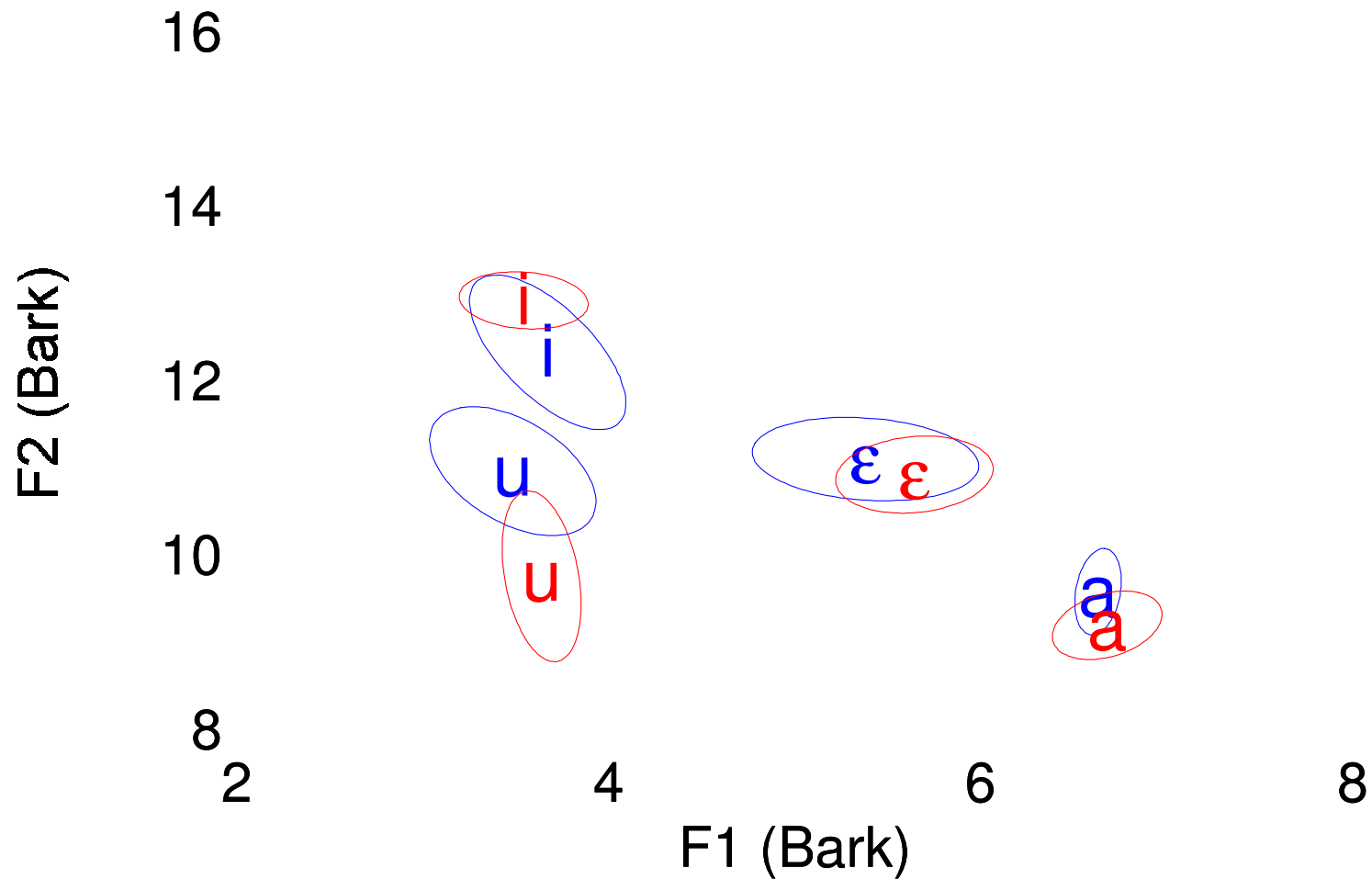
Speaker F2B – Accented in red



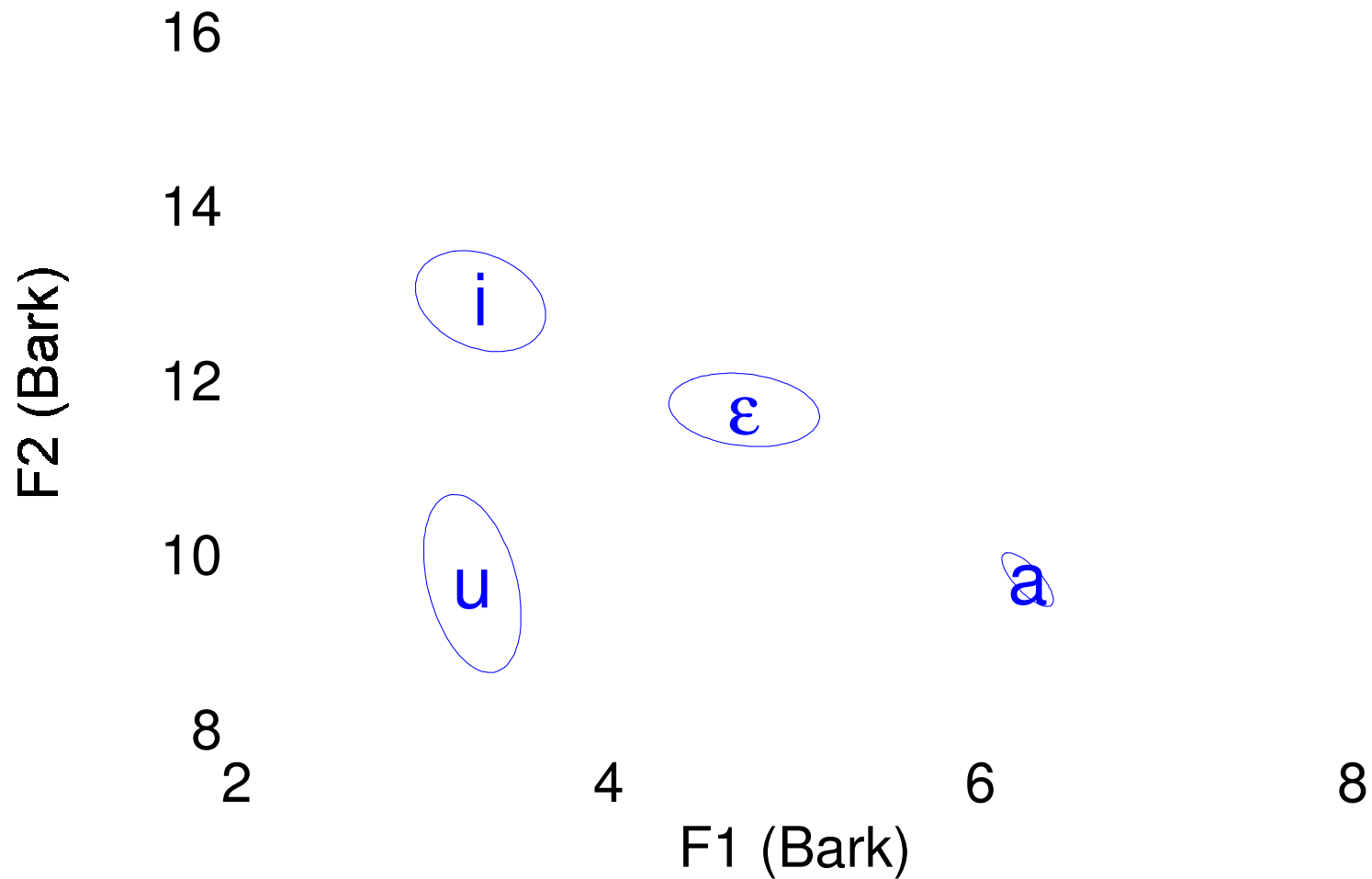
Speaker M1B – unaccented



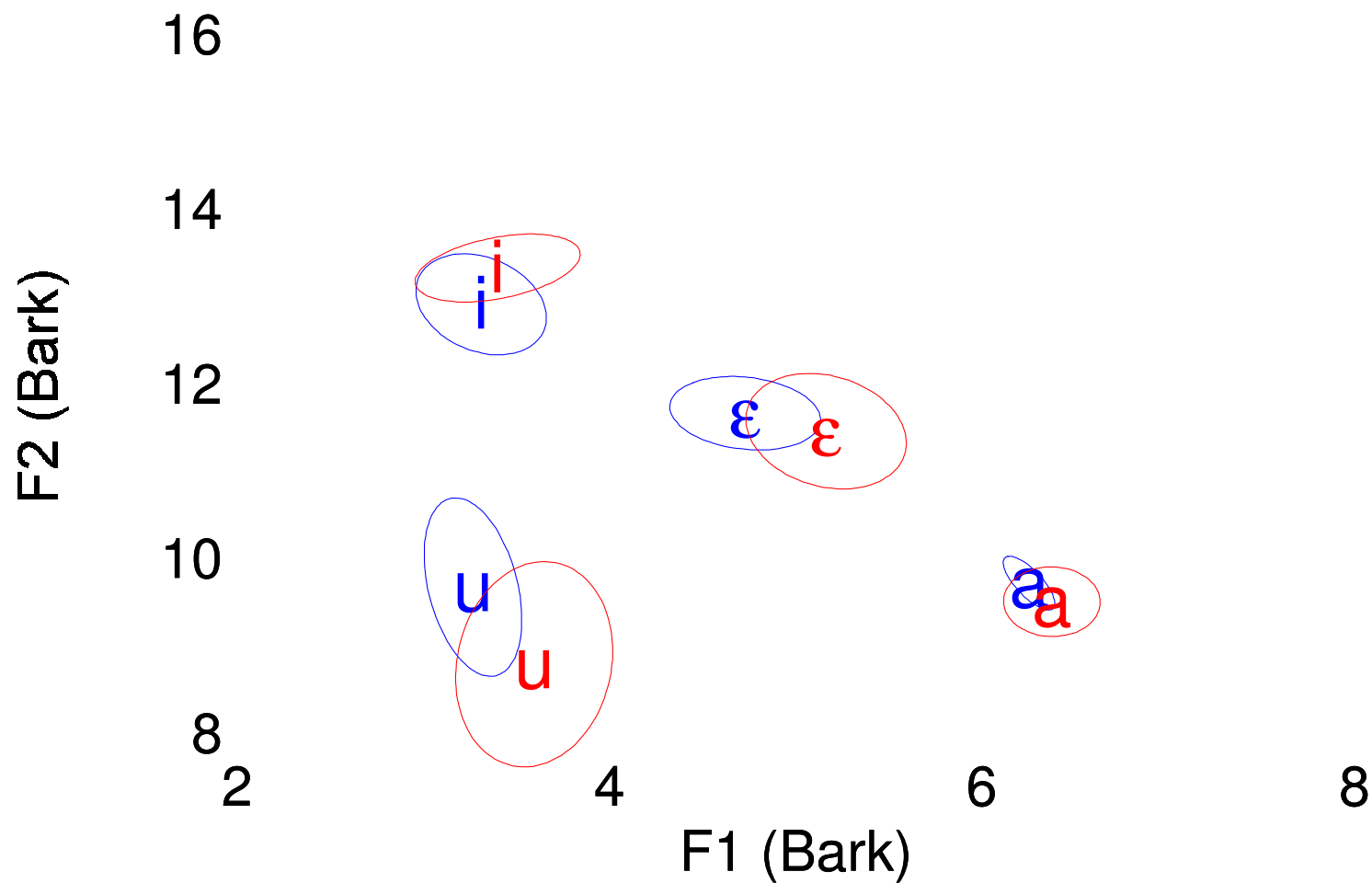
Speaker M1B – Accented in red



Speaker M2B – Unaccented



Speaker M2B – Accented in red



T-test

*: $p < .05$, **: $p < .01$, n.s.: not significant at $p < .05$

	i		ε		a		u	
	F1	F2	F1	F2	F1	F2	F1	F2
F3A	**	**	*	n.s.	n.s.	n.s.	n.s.	**
F2B	*	**	*	n.s.	n.s.	n.s.	*	*
M1B	*	**	*	*	n.s.	*	n.s.	**
M2B	n.s.	**	**	n.s.	n.s.	n.s.	*	*

T-test

*: $p < .05$, **: $p < .01$, n.s.: not significant at $p < .05$

	i		ε		a		u	
	F1	F2	F1	F2	F1	F2	F1	F2
F3A	**	**	*	n.s.	n.s.	n.s.	n.s.	**
F2B	*	**	*	n.s.	n.s.	n.s.	*	*
M1B	*	**	*	*	n.s.	*	n.s.	**
M2B	n.s.	**	**	n.s.	n.s.	n.s.	*	*

T-test

*: $p < .05$, **: $p < .01$, n.s.: not significant at $p < .05$

	i		ε		a		u	
	F1	F2	F1	F2	F1	F2	F1	F2
F3A	**	**	*	n.s.	n.s.	n.s.	n.s.	**
F2B	*	**	*	n.s.	n.s.	n.s.	*	*
M1B	*	**	*	*	n.s.	*	n.s.	**
M2B	n.s.	**	**	n.s.	n.s.	n.s.	*	*

T-test

*: $p < .05$, **: $p < .01$, n.s.: not significant at $p < .05$

	i		ε		a		u	
	F1	F2	F1	F2	F1	F2	F1	F2
F3A	**	**	*	n.s.	n.s.	n.s.	n.s.	**
F2B	*	**	*	n.s.	n.s.	n.s.	*	*
M1B	*	**	*	*	n.s.	*	n.s.	**
M2B	n.s.	**	**	n.s.	n.s.	n.s.	*	*



Summary

- Inter-speaker variation
- Major trends across speakers
 - accented [i] – more fronted (higher F2)
 - accented [u] – more back (lower F2)
 - accented [ɛ] – lower (higher F1)
 - accented [a] – NO lowering



- Accented vowels are better separated
- Asymmetric vowel space expansion
 - greater expansion for high vowels
 - greater expansion in backness than in the height dimension



Conclusion

- Partial support for the view of accent as hyperarticulation
- Main effect of accent is enhancement of backness feature
- No consistent sonority enhancement



Discussion

- Why no lowering effect on /a/?
 - Different pragmatic functions
 - Topic, new information marking
 - Our study on radio news speech
 - Contrastive focus
 - Previous studies on laboratory speech



Thank you.