

The background of the slide features a large, light gray watermark of the Stanford University seal. The seal is circular, with the words "LELAND STANFORD JUNIOR UNIVERSITY" around the top and "1891" at the bottom. In the center is a redwood tree with the words "LUFT DER FREIHEIT" (Air of Freedom) written in a circle around it.

Multiple Realizations of Creaky Voice

Evidence for Phonetic and Sociolinguistic Change in Phonation

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Introduction

Sociolinguists and phoneticians have enriched our understanding of creaky voice's social distribution and phonetic properties.

Phonetics

- plurality of realizations (e.g., Keating, Garellek, and Kreiman 2015)
- detailed analysis of smaller, more socially uniform datasets

Sociolinguistics

- complex social patterning
- less detailed acoustic analyses in larger, socially stratified datasets (e.g., Stuart-Smith 1999, Podesva 2013, papers in this session)

Our Central Claims

1. The phonetic realization of creaky voice is constrained by phrase position.
2. Phrase position effects are socially constrained, as younger speakers expand the range of prosodic environments in which creak occurs.

Public Discourses About Creaky Voice

A Vocal 'Pandemic' Among Young Women

THE HUFFINGTON POST

Singers like Britney Spears slip into vocal fry when hitting low notes or for sultry effect, [noted Science NOW's Marissa Fessenden](#), characterizing the creak as a “language fad.” [Kim Kardashian](#) is guilty of it. So is [Zooey Deschanel](#).

TIME

Listen to ***Slate***'s show about the much-reviled phenomenon, prominent among young American women, of “creaky voice.”

Slate

the annoying young woman

Social Distribution of Creaky Voice

Variationist work complicates ideologies circulating in the media.

Social perception studies: creak not always evaluated negatively

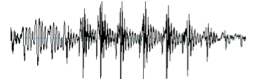
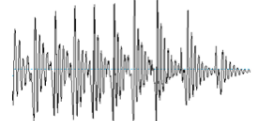
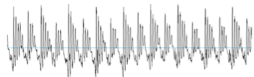
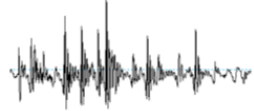


- Only older listeners evaluated creaky negatively (Eckert 2013)
- Creaky samples judged as sounding “professional” (Yuasa 2010)

Production studies: prevalence of creak outside the speech of young (white) women

- Men in UK (Esling 1978, Henton & Bladon 1988, Stuart-Smith 1999)
- Chicano character types (cholo, gangster) in media representations (Mendoza-Denton 2011)
- Women of all ages in DC, including African Americans (Podesva 2013)

Most sociolinguistic work has identified creak using auditory methods, which cannot differentiate different types of creak.

Different Kinds of Creak

	phonetic property →	low F0	irregular F0	glottal constriction	damped pulses	sub-harmonics
	main acoustic correlate →	(low F0)	(high noise)	(low H1-H2)	(low noise, narrow BW)	(high SHR)
	1. prototypical	✓	✓	✓		
	2. vocal fry	✓		✓	✓	
	3. multiply pulsed		✓	✓		✓
	4. aperiodic	NO	✓	✓		
	5. nonconstricted	✓	✓	NO		
	6. tense	NO		✓		

Three Approaches to Characterizing Creak

Single Acoustic Measure: H1*-H2*

- open quotient, inversely correlates with degree of glottal constriction
- **interpretation**: low values indicative of creakier phonation
- **pro**: nearly all types of creak characterized by glottal constriction
- **con**: does not correlate with nonconstricted creak (Slifka 2006)

Single Acoustic Measure: CPPS

- cepstral peak prominence (smoothed), correlates with degree of periodicity
- **interpretation**: low values indicative of creakier phonation
- **pro**: captures most types of creak, including nonconstricted
- **con**: also correlates with other less periodic (e.g., breathy) phonation types

Multiple Acoustic Measures: Creak Classification (Kane, Drugman & Gobl 2013)

- classification using neural network model of multiple acoustic measures
- **interpretation**: all intervals classified as \pm creak
- **pro**: holistic, binary coding may approximate (some listeners') perception
- **con**: kinds of creak undifferentiated


Positional Constraints on Creaky Voice

Creaky voice generally favored in phrase-final position (e.g., Henton and Bladon 1988, Ogden 2011, Podesva 2013)

Stylistic use of non-final creak

- The most burned-out burnout uses more non-final creak than the most squeaky-clean jock (D'Onofrio, Hilton, and Pratt 2013).
- Chinese listeners evaluate non-final creak differently from final creak (Callier 2014).
- A Japanese adult video actress exhibits increased use of non-final creak (Kajino and Moon 2011) in “sexy” talk.

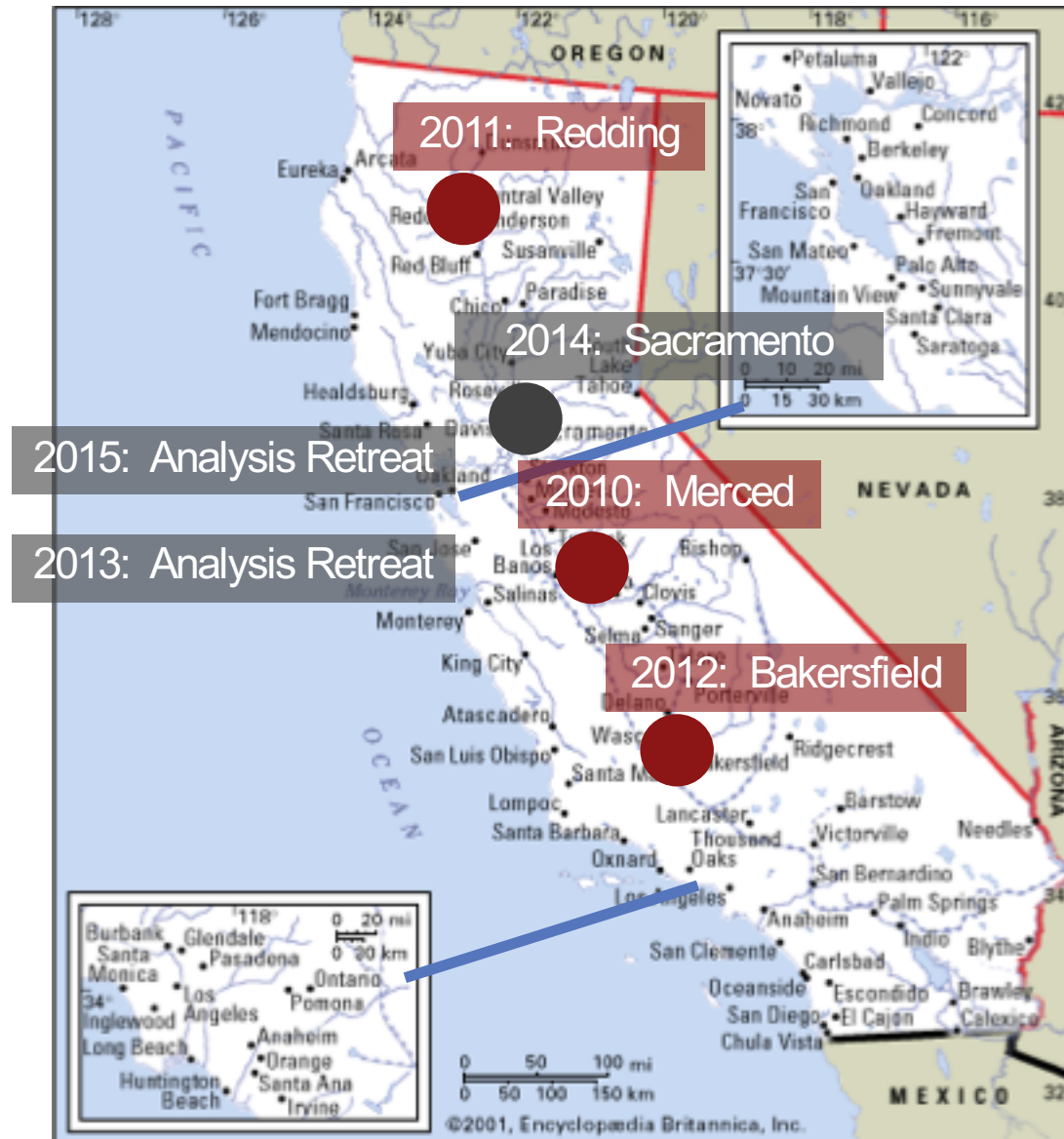
Extensive Creaky Voice

-  Interviewer: When- When did they- When did your parents *get* a divorce?
Jessica: Uh- Shortly after (.) *we had moved there*,
Jessica: They were in the *process of getting a divorce*
Interviewer: Oh I see.
Jessica: So we moved up there,
Jessica: And then,
Jessica: *They decided to get a divorce so we moved back.*

Our Central Claims

1. The phonetic realization of creaky voice is constrained by phrase position.
2. Phrase position effects are socially constrained, as younger speakers expand the range of prosodic environments in which creak occurs.

Data



Roughly hour-long
sociolinguistic interviews by
student and faculty
fieldworkers for **Voices of
California Project**

3 field sites

- Redding
- Merced
- Bakersfield

Sample

93 white speakers					
32 from Bakersfield		31 from Merced		30 from Redding	
16 female	16 male	16 female	15 male	16 female	14 male
22-90 years old	24-81 years old	26-93 years old	18-90 years old	18-73 years old	18-63 years old

1/3 of the speakers (represented in all cells) earn their livelihood off the land (e.g., agriculture, ranching, logging, oil).

Methods

Annotation

- Orthographic transcriptions in ELAN (Lausberg & Sloetjes 2009) or Transcriber (Barras et al. 1998)
- Forced alignments generated with FAVE (Rosenfelder et al. 2011)

Extraction of Acoustic Measurements

- Measurements taken for all vowel intervals every 10 ms in Praat (Boersma and Weenink 2015), based on methods in Vicenik (nd), Iseli et al. (2007), Shue (2009)
- Spectral tilt: **H1*-H2***, H1*-A1*, H1*-A2*, H1*-A3*, A1*-A3*, 2k-5k
- Periodicity: cepstral peak prominence (CPP), **smoothed CPP (CPPS)**, harmonics-to-noise ratio (HNR), HNR on low-pass filtered spectrum (500Hz: HNR05, 1500 Hz: HNR15, 2500 Hz: HNR25)
- Nasality: A1*-P0
- F0, F1, F2, intensity

Methods

Post-Processing

- Data reduced to one record (median) per vowel segment
- Exclusions
 - phone duration $\leq 50\text{ms}$ or $\geq 283\text{ ms}$ (median of log duration + 2 s.d.)
 - outliers (± 2 s.d) in F1, F2, intensity, log F0, A1*-P0
- Phrase segmentation from pauses; position in phrase from 0 to 1, based on vowel midpoint
- Preceding and following segments from aligned TextGrids
- Intensity normalization by speaker mean intensity
- Word frequency from in-corpus token count

Creak Detection

- All vowels coded as **\pm creaky** by a neural network classifier
- MATLAB implementation of Kane, Drugman, and Gobl (2013) algorithm, which factors in a number of acoustic parameters

Methods

Statistical Analysis

Response

H1*-H2* (linear model), **CPPS** (linear model),
 \pm **creaky** (logistic model)

Random Effects
(intercepts)

speaker, preceding sound, following sound

Fixed Effects

Linguistic

F1, F2

F0*

phone duration*

intensity

word frequency*

phrase position

IP duration*

A1*-P0

Social

sex

age (linear and quadratic terms)

field site

land orientation

All continuous variables were scaled and centered.

* log-transformed to ensure normal distribution

H1*-H2*: Linguistic Factors

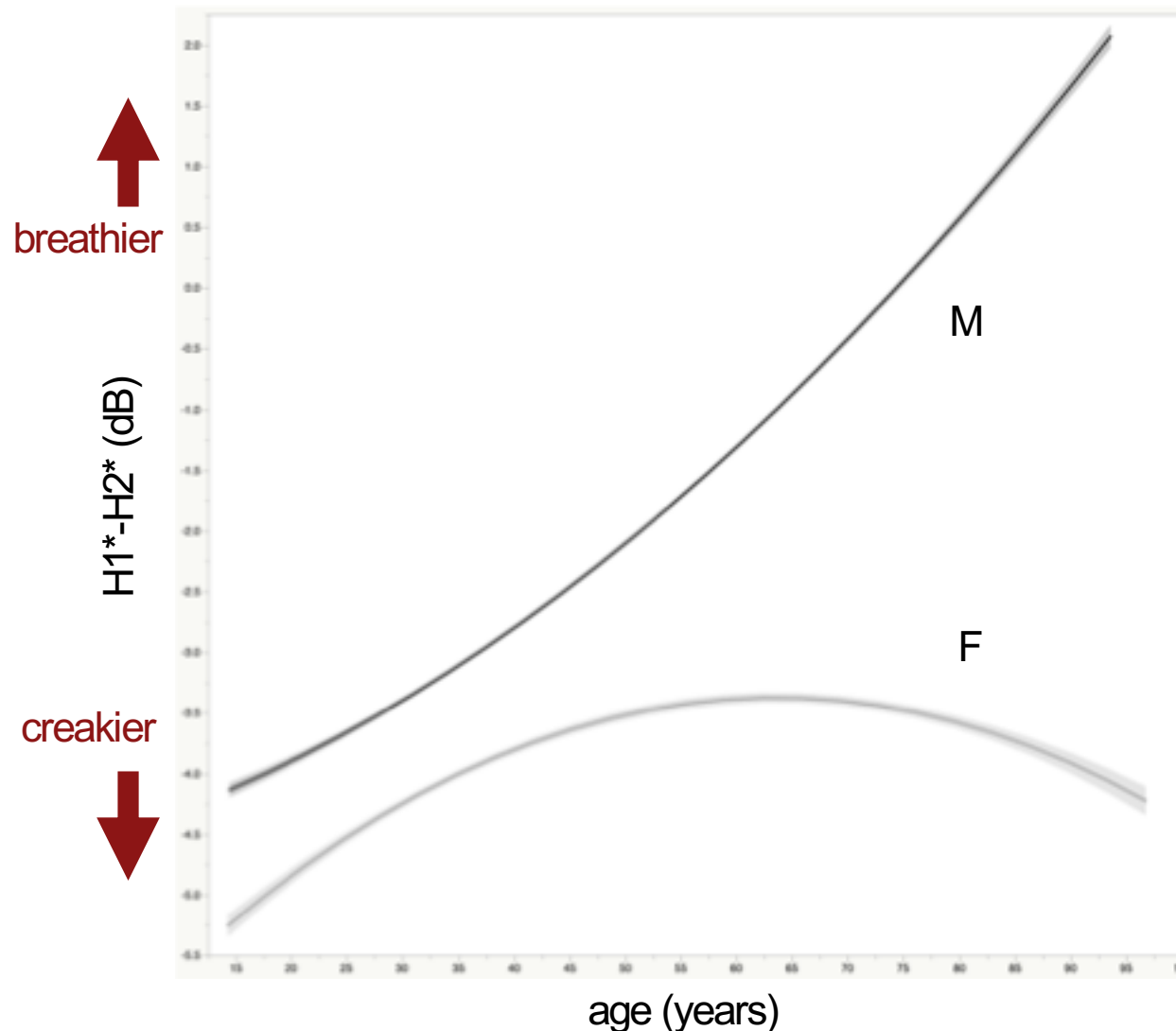
Previous Results (Podesva, Callier, and Szakay 2015)

Creaky voice stronger

- at lower **F0** (F0 effect decreases with **intensity**)
- for vowels exhibiting longer **duration**
- at later **phrase positions** (for female speakers only)
- with greater **nasality** for men, lesser for women
- for words with higher **frequency**

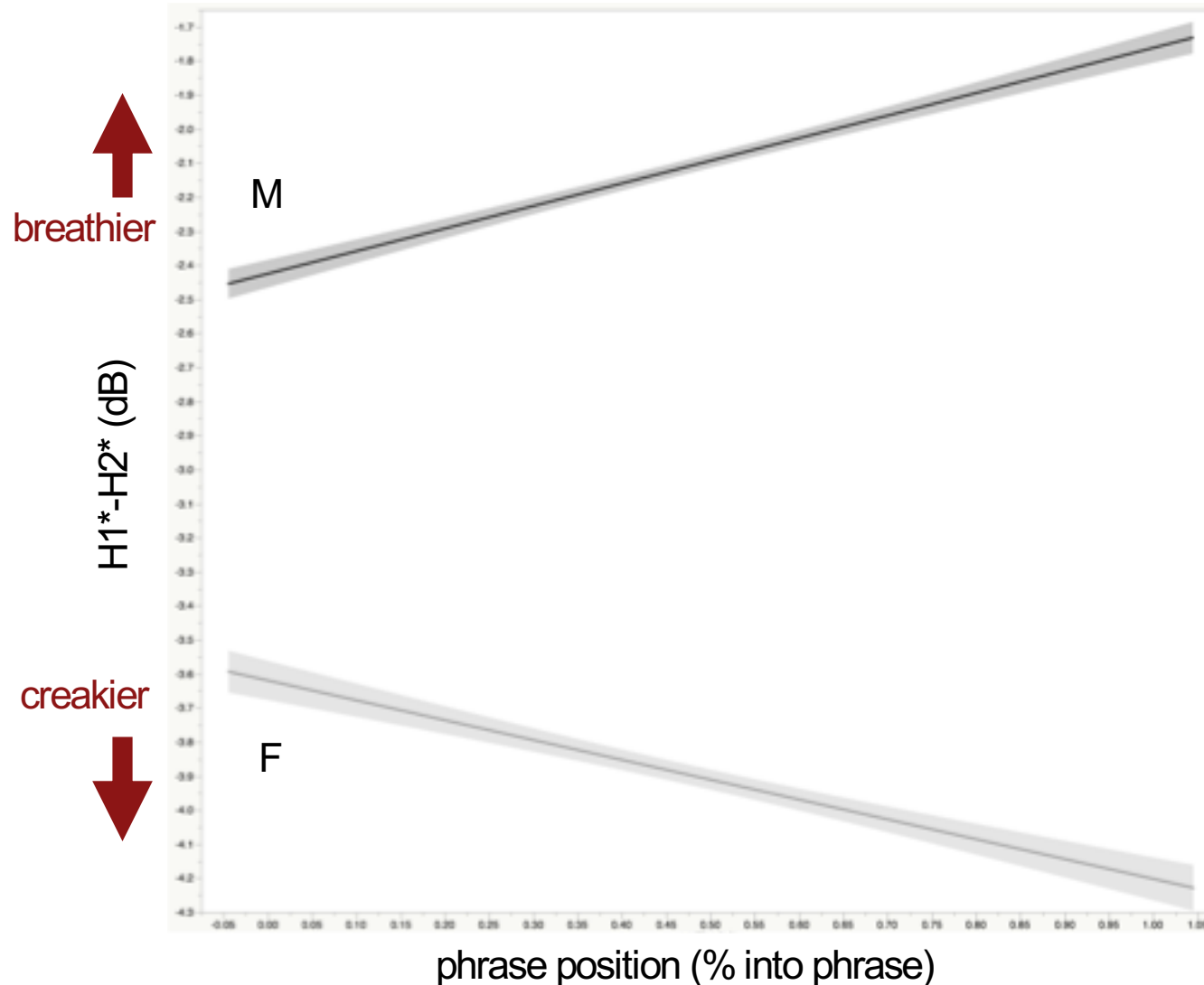
All linguistic factors and relevant interactions were included in statistical models that incorporate social factors.

H1*-H2*: Sex * Age Interaction



- Women are creakier than men (in spite of Simpson's 2012 finding that H1-H2 inflates breathiness values for females).
- Older men are breathier than younger men (linear term for age interacts with gender).
- Women show a curvilinear pattern, with highest incidence of creak among the youngest and oldest women (quadratic term for age interacts with gender).

H1*-H2*: Sex * Phrase Position Interaction



- Men appear to exhibit the opposite pattern from women... but are they really becoming less creaky at the ends of phrases?
- Women exhibit the canonical pattern, with the degree of creak increasing at later phrase positions.

CPPS

cepstral peak prominence (smoothed), correlates with degree of periodicity
interpretation: low values indicative of creakier phonation

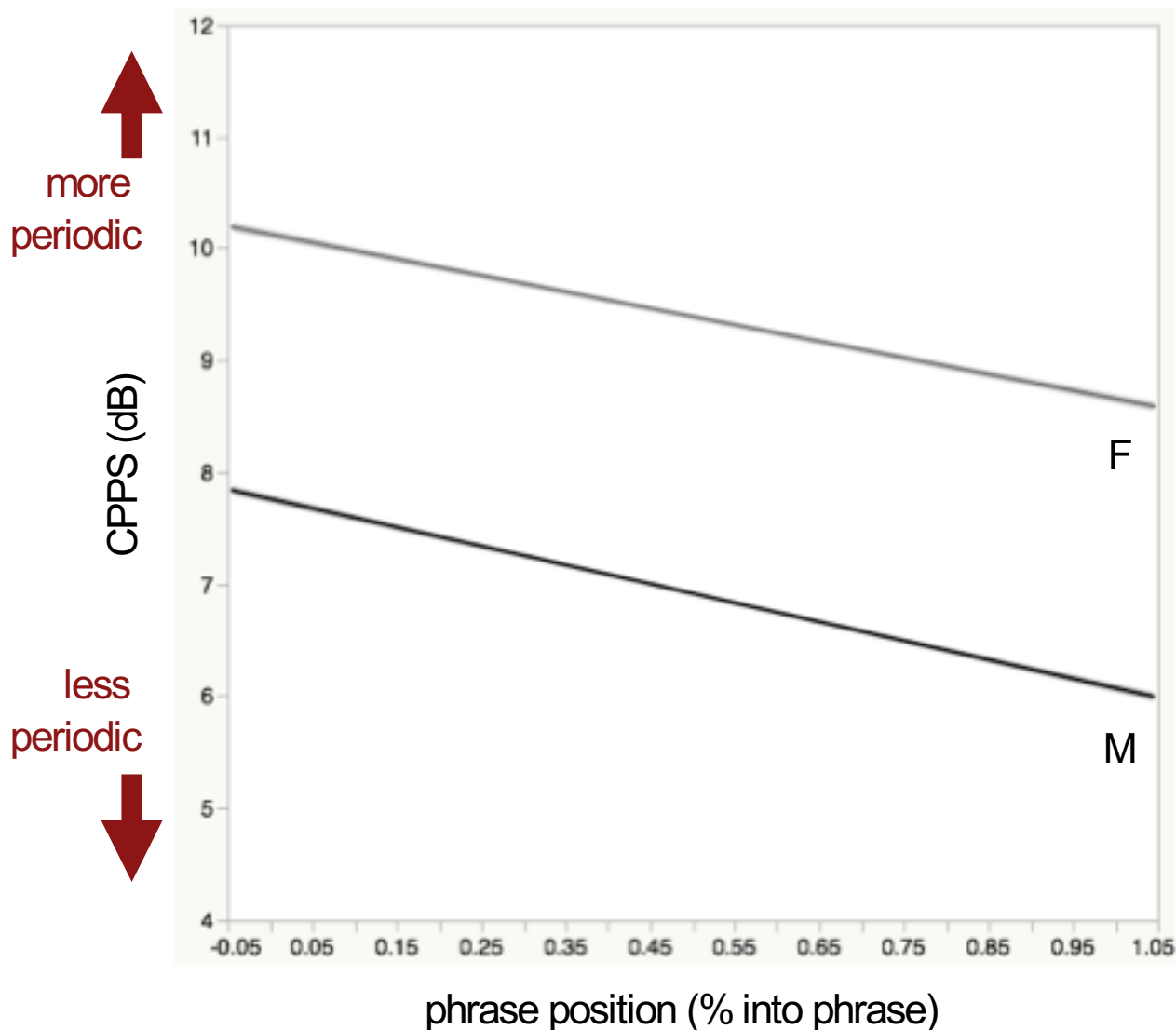
Linguistic Factors

- generally the same as $H1^*-H2^*$, except
- longer vowels more periodic than short vowels

Social Factors

- women more periodic than men
- no effects of age

CPPS: Phrase Position (by Sex)



- Both women and men become less periodic as the phrase progresses.
- Women are creakier at the ends of phrases (H1*-H2* and CPPS patterns converge).
- Men might be creakier at the ends of phrases (CPPS patterns could indicate increased breathiness).

Creak Detection

All vowels classified as \pm creaky using Kane, Drugman, and Gobl's (2013) neural network model, which takes several acoustic measures into account.

Linguistic Factors

- generally the same as $H1^*-H2^*$
- exception: higher incidence of creak for vowels in shorter phrases

Social Factors

- generally the same as $H1^*-H2^*$, including sex, age, and interaction
- exception: less creak among land-oriented speakers
- exception: interaction between phrase position and age

Creak Detection: Relationship to Land

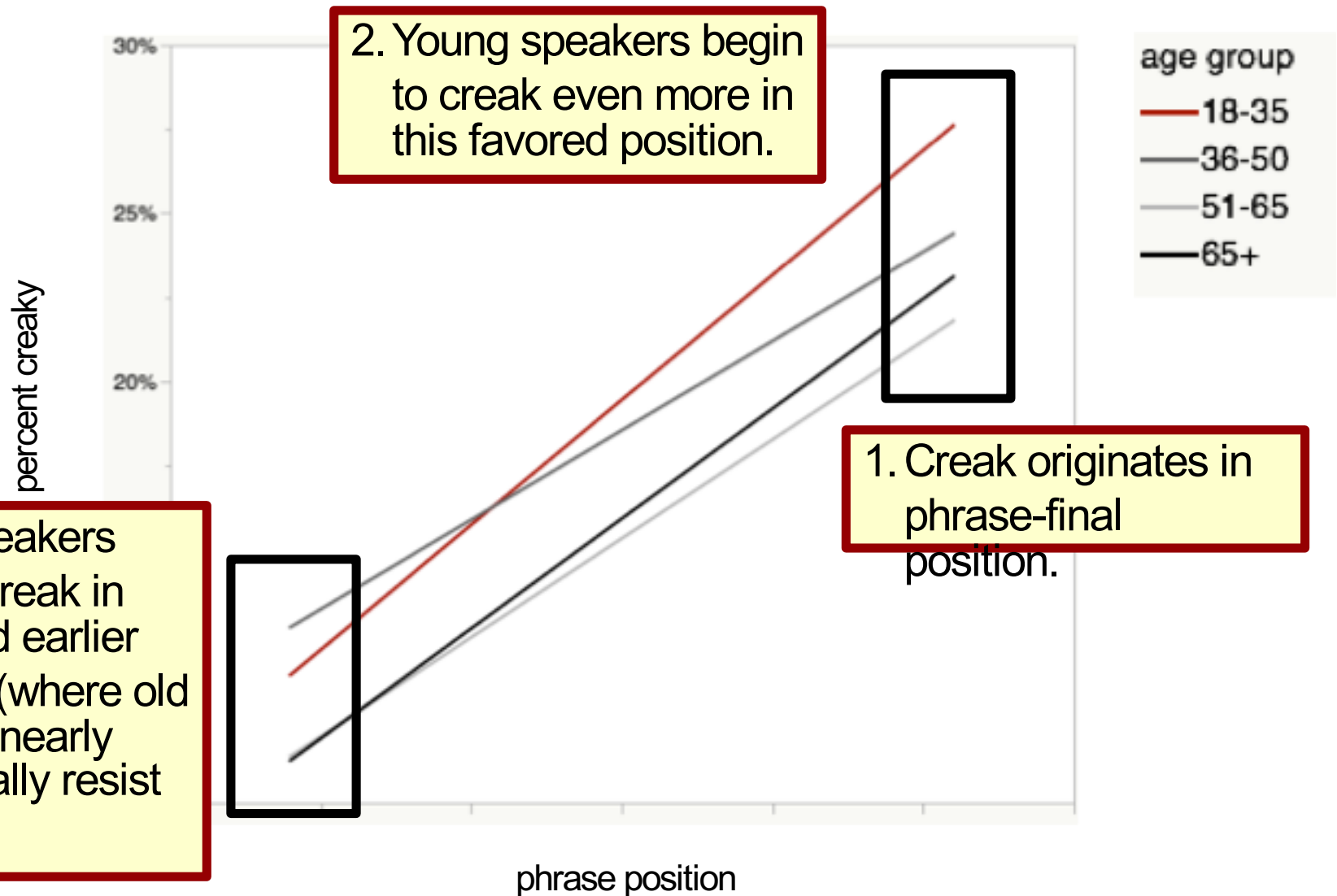


Similar Effects

- local vowel shift (Podesva, D'Onofrio, Van Howegen, and Kim 2015)
- /s/ retraction (Podesva and Van Hogwegen 2014)
- strength of stop voicing (Podesva et al. 2015)

← creaky

Creak Detection: Age * Phrase Position Interaction

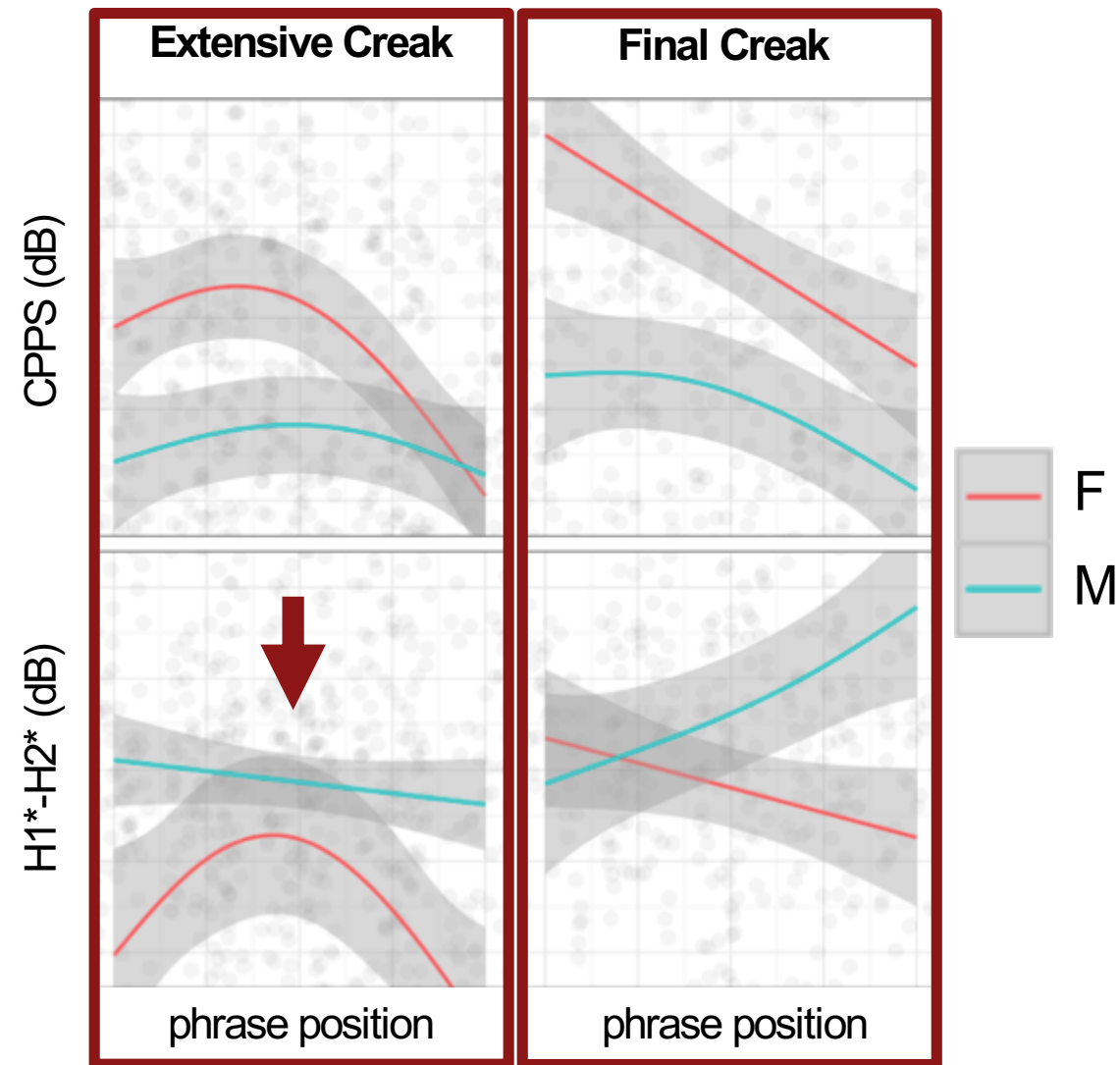


Acoustic Character of Extensive Creak

Hand-coded subset (500 final creak phrases) is the same as that in the full corpus, suggesting sex class differences in implementation of creak more syllables before nuclear phrase accent)

Extensive creak (one or more syllables before nuclear phrase accent)

The sex class difference does not hold for extensive non-final creak, where women and men both show increased glottal constriction (low $H1^*-H2^*$).



Conclusion

Summary of Social Distribution

Sex	Women exhibit stronger, more common creak than men. But strong creak among young men and older women, too!
Age	Change in apparent time, achieved by <ol style="list-style-type: none">1. more phrase-final creak2. expansion of domain to earlier in the phrase
Land	Speakers who earn their living off the land creak less (cf. Yuasa's 2010 claim about urbanity)

Conclusion

Summary of Phonetic Variation in Realization of Creaky Voice

1. Sex differences in the realization of final creak

Men exhibit higher $H1^*-H2^*$ (decreased glottal constriction)
(cf. Slifka 2006)

1. Positional differences in the realization of creak

Non-final, extensive creak characterized by uniformly low $H1^*-H2^*$
(increased glottal constriction), exhibiting no sex differences

Conclusion

Implications for Public Discourses About Creak

Creak's appearance in recent public discourses may be due to

- increased use
- distinctive acoustic character in non-final position, where it is gaining ground

Creak is prevalent among women *of a variety of ages*, as well as young *men*.

Conclusion

Value of Taking Multiple Approaches

A single acoustic measurement may not always be available as a proxy for a phenomenon of interest.

Example: creaky voice and phrase position among men

1. CPPS lowers as the phrase progresses.
But is it breathier or creakier?
2. Creak detection shows increased incidence of creak.
But what kind of creak is it?
3. $H1^*-H2^*$ increases as the phrase progresses.

So men exhibit a decreased degree of glottal constriction (i.e., a non-prototypical type of creaky voice) for final creak.

Conclusion

Future Work

Trans men and the biological vs. learned basis of sex differences
(collaboration with Zimman)

Discursive, interactional, and embodied contexts in which speakers creak
Podesva, Callier, Voigt, and Hilton (this conference)
Creaky voice more common when speakers move less, aren't smiling,
and report feeling less comfortable.

Understanding the range of social meanings that creaky voice conveys is
essential for understanding its trajectory of change.

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Thank You!

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and Stanford University for funding data collection.

Questions?

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