PROBING **VOICE QUALITY'S** CONTRIBUTION TO TONE PERCEPTION:

CHALLENGES FOR SYNTHESIS SOFTWARE

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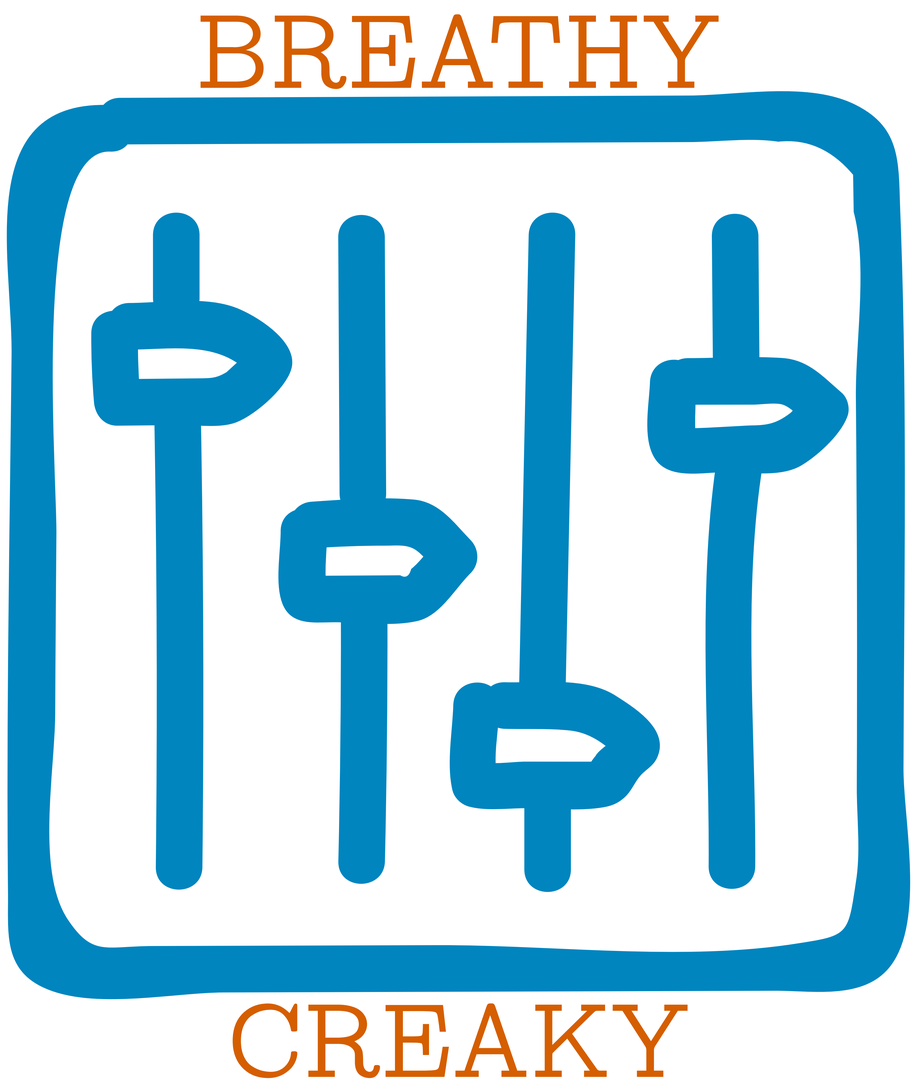
INTRODUCTION

Understanding interaction of fundamental frequency and other aspects of voice quality in tone perception demands fine control of voice quality in stimulus design.



Strategies for voice quality stimuli design

- **Use library of exemplars collected from natural speech**
- **Synthesize from scratch using voice quality synthesizer**

- **Synthesis from scratch enables isolation of parameters that can be confounded in naturally produced stimuli, e.g., types of creak** (Keating et al. 2015, Garellek 2019)
- **But relation of output to properties of natural speech *entirely dependent on underlying physical/mathematical model***

KlattGrid

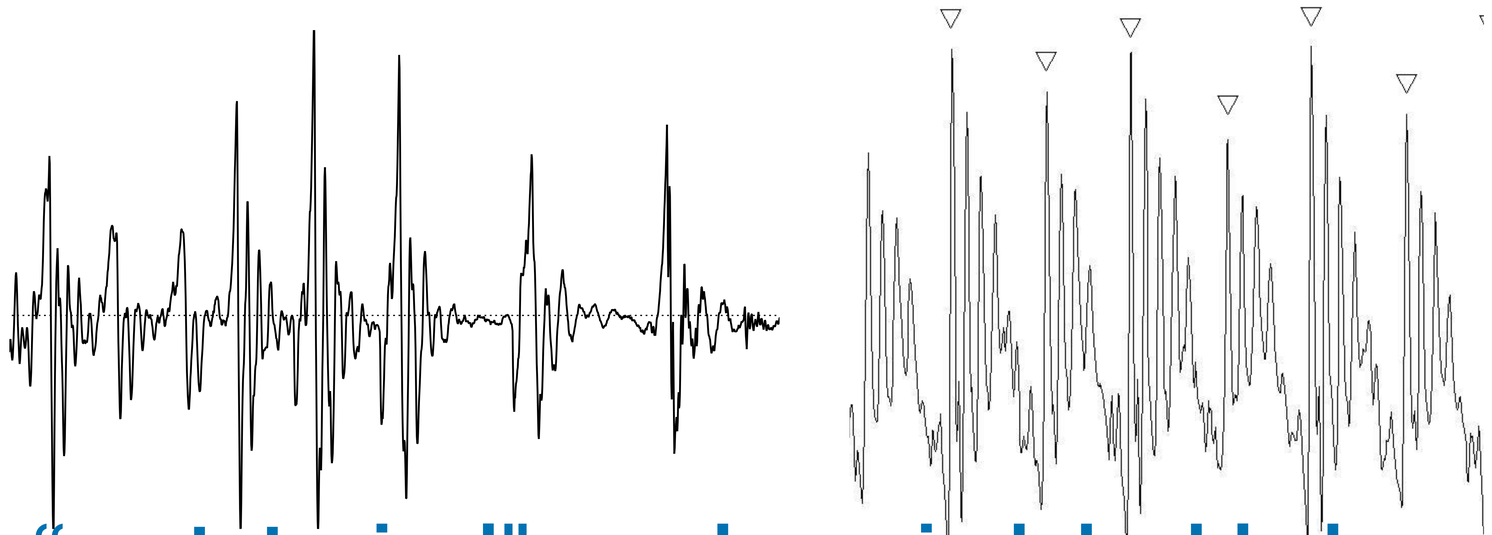
(Weenink 2009)

Brunelle 2012: Cham,
Zhang & Kirby 2018: Cantonese,
Huang 2019: Mandarin)

UCLA Voice Synthesizer

(Kreiman et al. 2010)

(Garellek et al. 2013: Hmong)



"prototypical" creak period doubled creak

How well does individually manipulating voice quality parameters in these tools produce stimuli with desired acoustic properties?

METHODS: parameters varied

KlattGrid parameters individually varied while others held constant at two default settings for [a]: man (M), woman (W)

PARAMETER	DESCRIPTION
TL (dB)	Spectral tilt
DI (%)	Double pulsing/period doubling
OQ (%)	Open phase/quotient
FL (%)	Flutter: fluctuations in f0
F0 (Hz)	Fundamental frequency
AH (dB SPL)	Breathiness amplitude

Just these shown in results

UCLA synthesizer

(stimuli from Garellek et al. 2013)

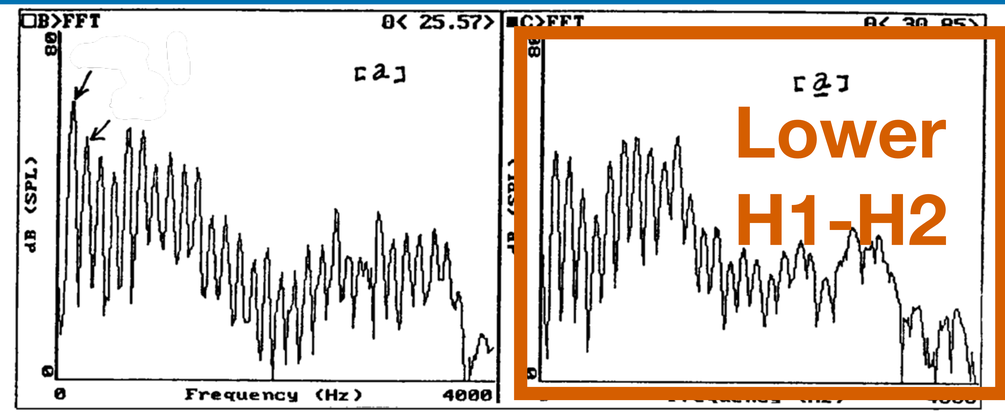
PARAMETER VARIED	MANIPULATION
H1	H1-H2 ↑
H2	H1-H2 ↑, H2-H4 ↓
H4	H2-H4 ↑, H4-2kHz ↓
2kHz	H4-2kHz ↑, 2kHz-5kHz ↓
5kHz	2kHz-5kHz ↑

METHODS: acoustic analysis

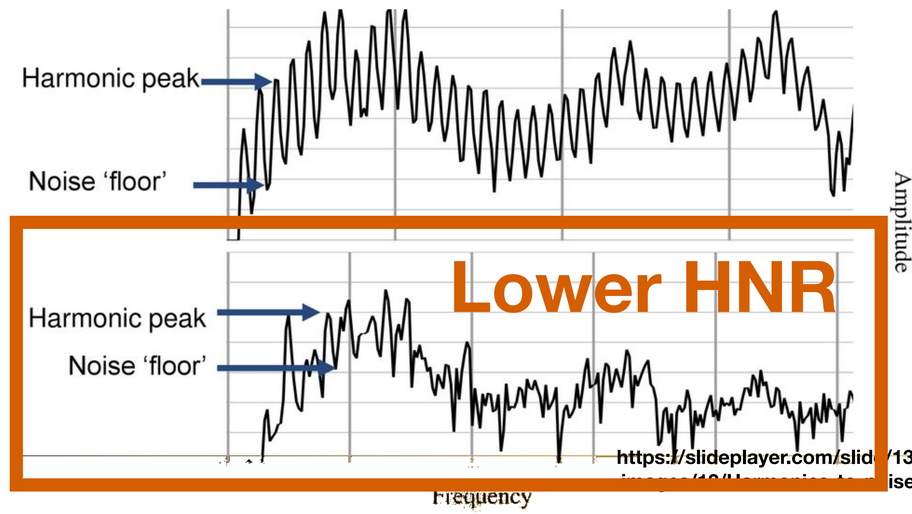
- Acoustic voice quality parameters measured using VoiceSauce (Shue et al. 2011)
- Regression analysis in R, with synthesis parameter as IV, acoustic parameter as DV

EXAMPLE

- Period-doubled creak has low H1-H2 (low spectral tilt) and high noise (low HNRs) (Keating et al. 2015)
- Therefore we'd like to see increase in KlattGrid DI lower HNR and H1-H2



Kong (1996)



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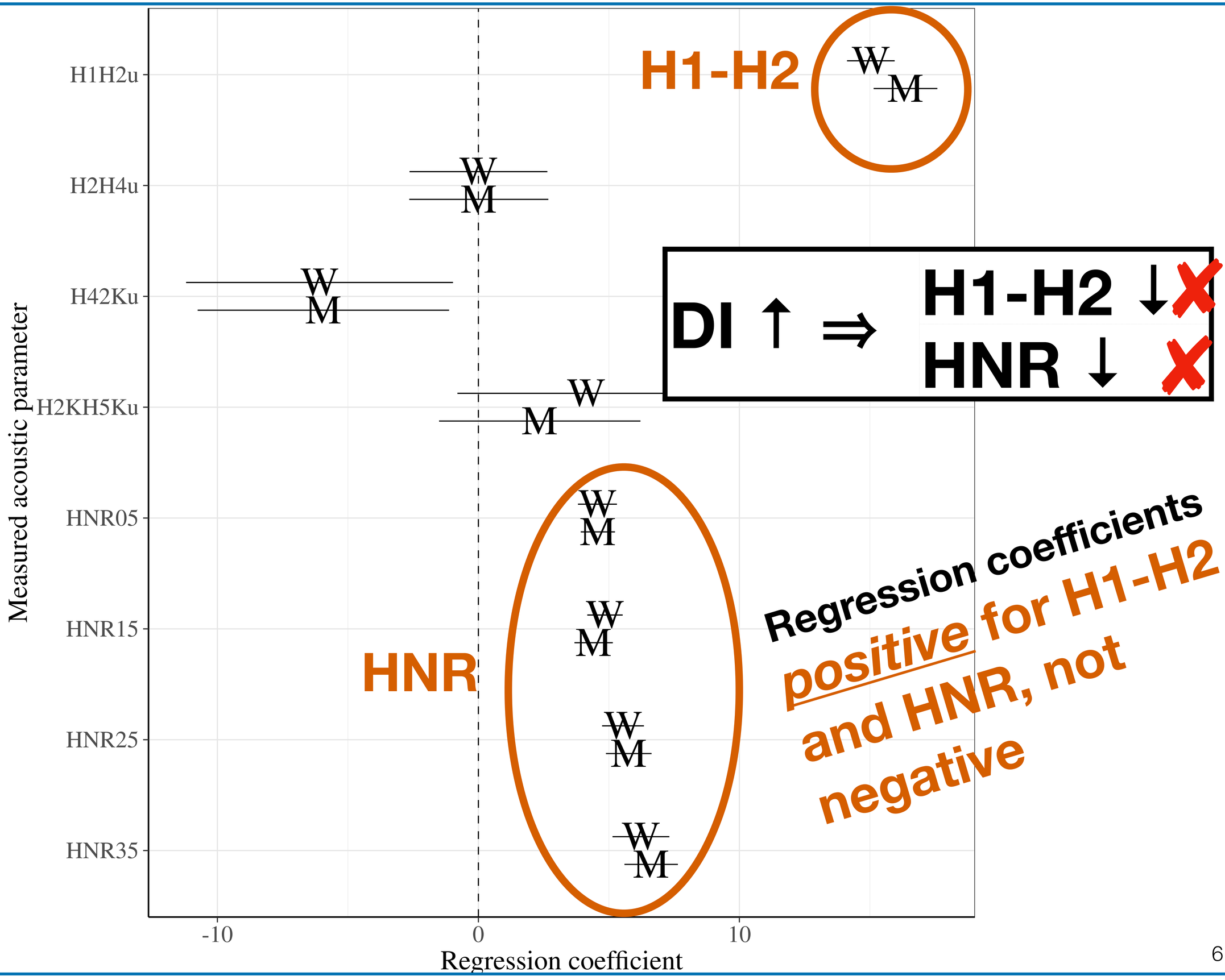
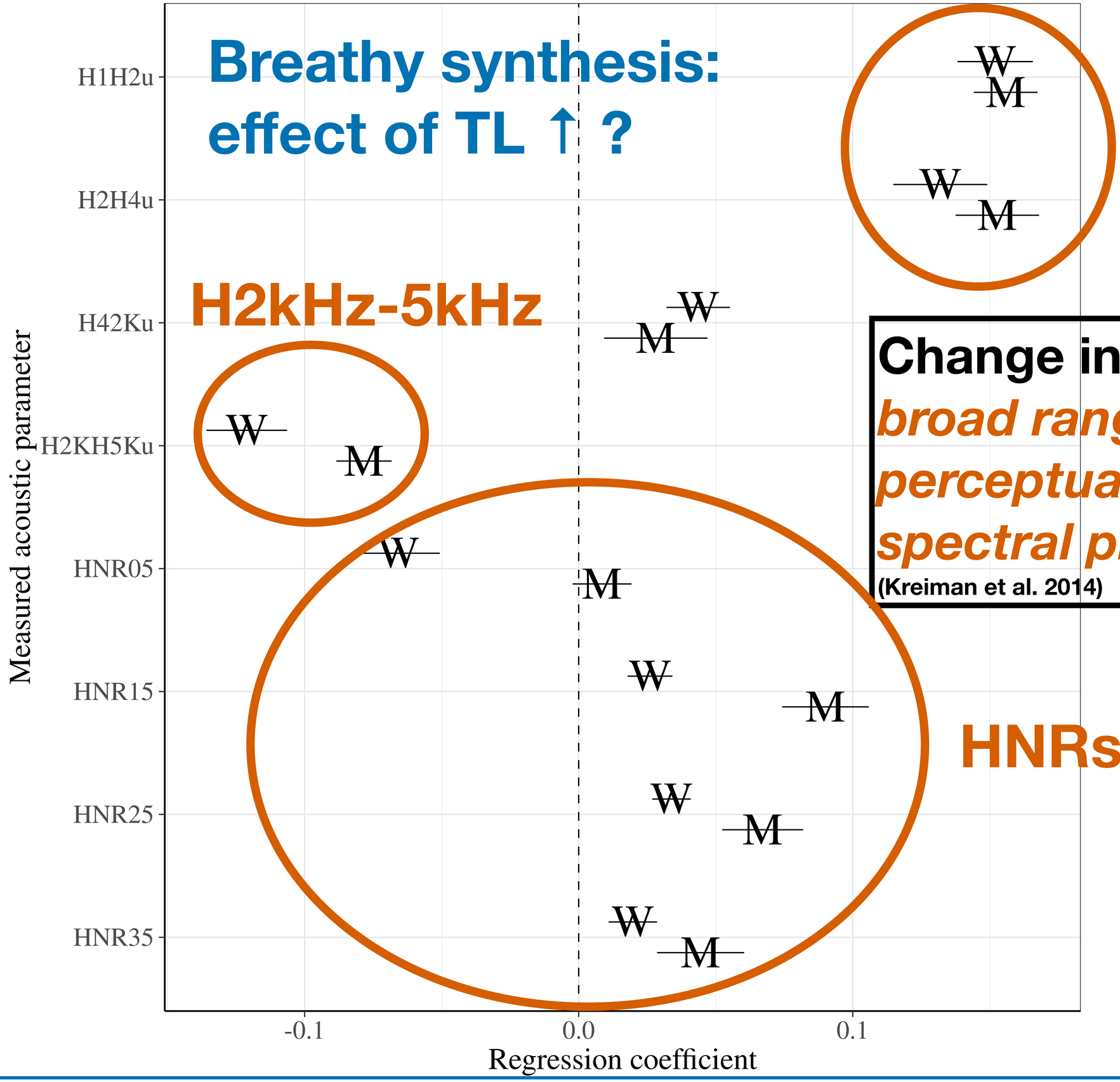
Klatt: DI (period doubling)



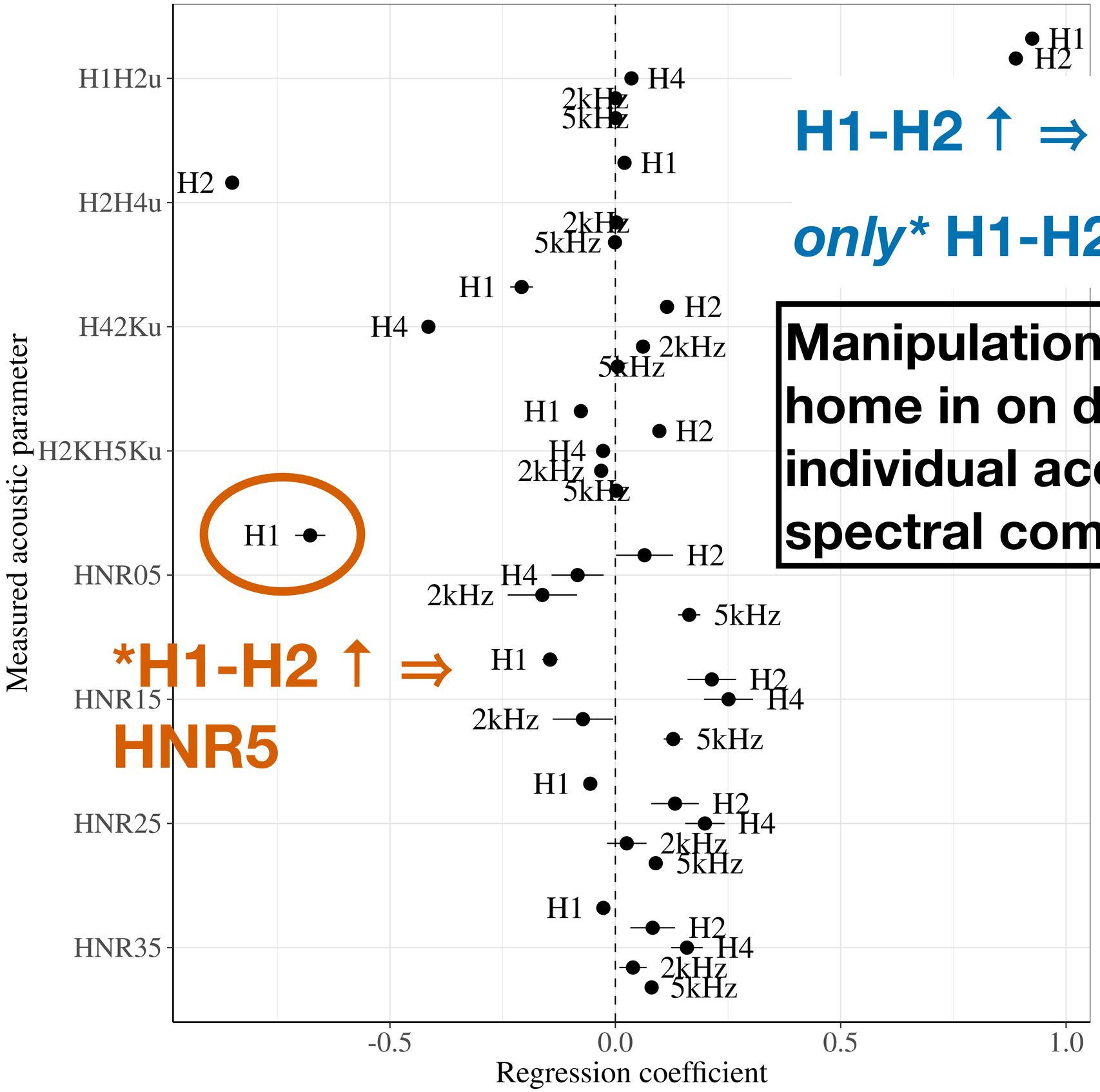
Klatt: TL (spectral tilt)

Breathy synthesis: effect of TL ↑ ?



Change in TL targets
broad range of perceptually distinct spectral properties
(Kreiman et al. 2014)

UCLA: spectral measures



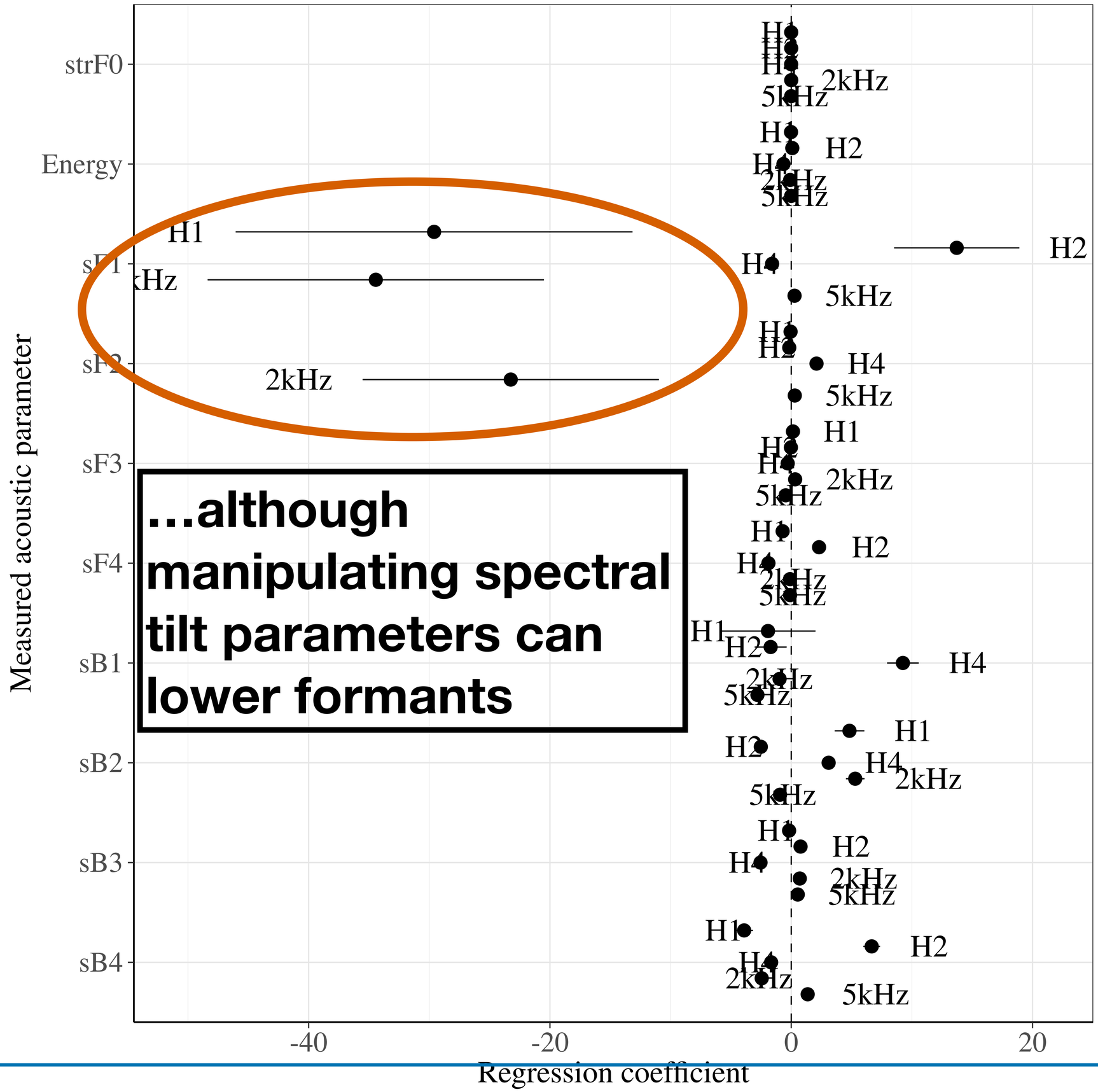
H1-H2 ↑ ⇒

only H1-H2 ↑*

Manipulations mainly home in on desired individual acoustic spectral components…

***H1-H2 ↑ ⇒ HNR5**

UCLA: f0, energy, formants



CONCLUSION

- **Not clear that KlattGrid synthesis of period-doubled creak by manipulating DI produces stimuli with the properties of naturally produced period-doubled creak.**
- **KlattGrid synthesis of breathiness using TL, OQ, AH doesn't home in on desired acoustic properties as well as UCLA Voice synthesizer**

Further work needed to define models that can synthesize voice quality for perception experiments, especially for creaky stimuli.

For further results and analyses, see OSF repository: https://bit.ly/2HPXmvd