Sensory biases in vocal communication

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Outline

- Sensory biases
- Mechanism 1: cross-modal associations
- Mechanism 2: attention and salience
- Mechanism 3: esthetics
- In-depth example: beautiful languages

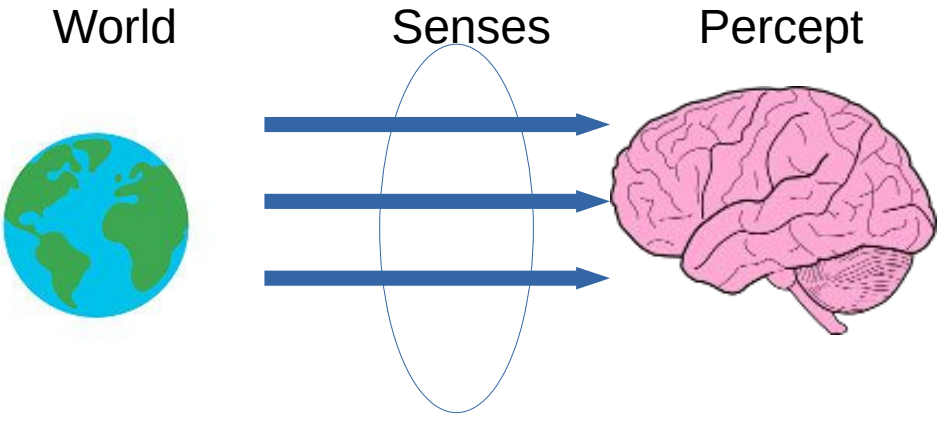
Nonverbal signals

- Facial expressions
- Laughs, grunts, barks, ...
- Gestures
- Bodily postures
- Olfactory signals, somatic features, haptic communication
- ...

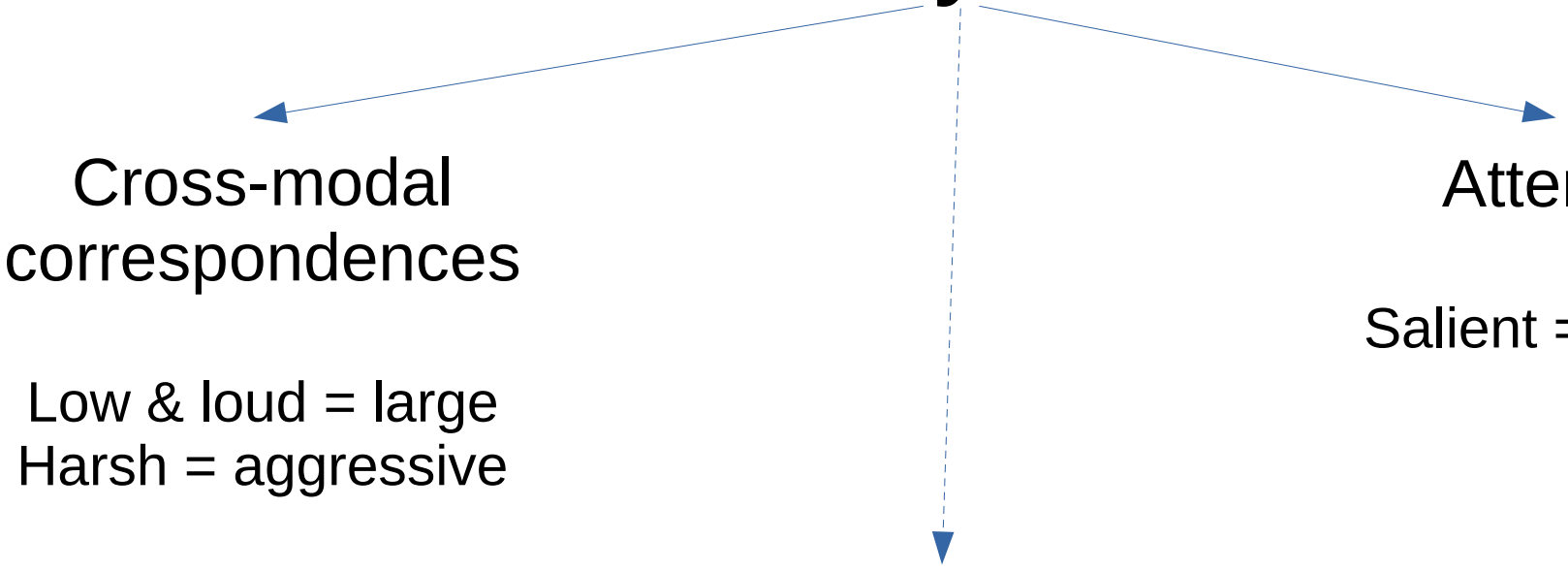
Perceived through the prism of sensory system

Sensory biases

- Perceive the world as is ≠ as we evolved & learned to perceive it
- Sensory biases = perceptual distortions (eg increased sensitivity to some sensory features)



Sensory biases



Cross-modal correspondences

Low & loud = large
Harsh = aggressive

Attention

Salient = intense

Esthetics

Repel with ugly, attract with attractive

Need for general principles

- The “**How**” of acoustic code is confusing
  - Dozens of acoustic variables reported
  - Within- vs across-type variation
- The “**Why**” of acoustic code
  - Generally applicable principles of animal & human vocal communication
  - Rooted in evolution & cognition

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Cross-modal correspondences

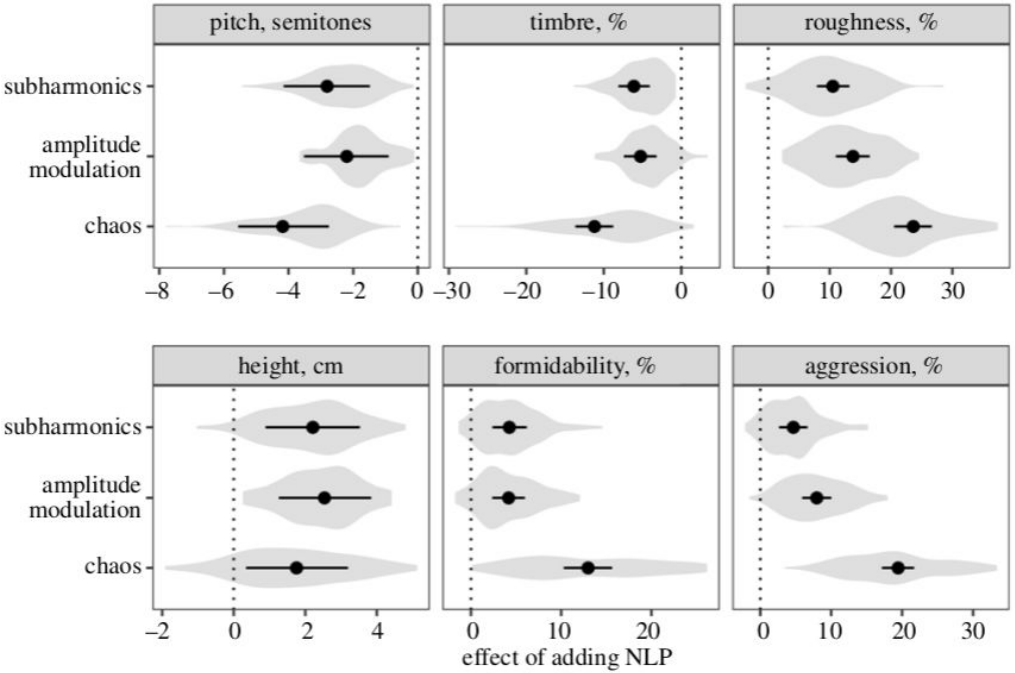
- Synesthesia (actual sensory experience)
- Implicit associations between sensory modalities

Acoustic size exaggeration

- Ecologically important to sound big (sexual selection, mating contests)
- Anatomical adaptations for low pitch
- Vocal tract elongation
- ...what else?

What else #1: harsh is large

- Harsh voices sound lower
- Good for vocal intimidation or size exaggeration



PROCEEDINGS B

royalsocietypublishing.org/journal/rspb

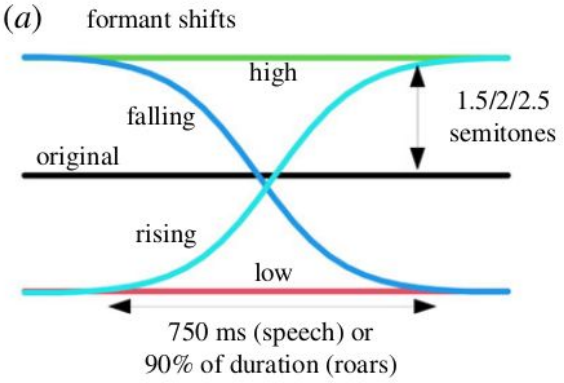
Harsh is large: nonlinear vocal phenomena lower voice pitch and exaggerate body size

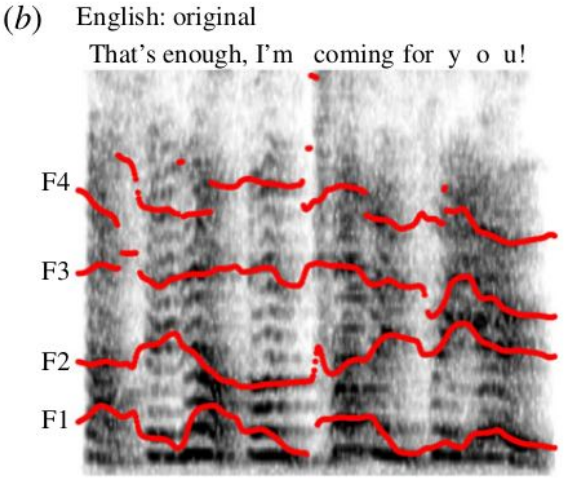
Andrey Anikin[1,2], Katarzyna Pisanski[2,3], Mathilde Massenet[2] and David Reby[2]

Research

What else #2: dynamic VTL

- Shifting resonances gradually vs. scaling them statically
- Static best for size exaggeration
- Dynamic best for expressing emotion





ROYAL SOCIETY OPEN SCIENCE

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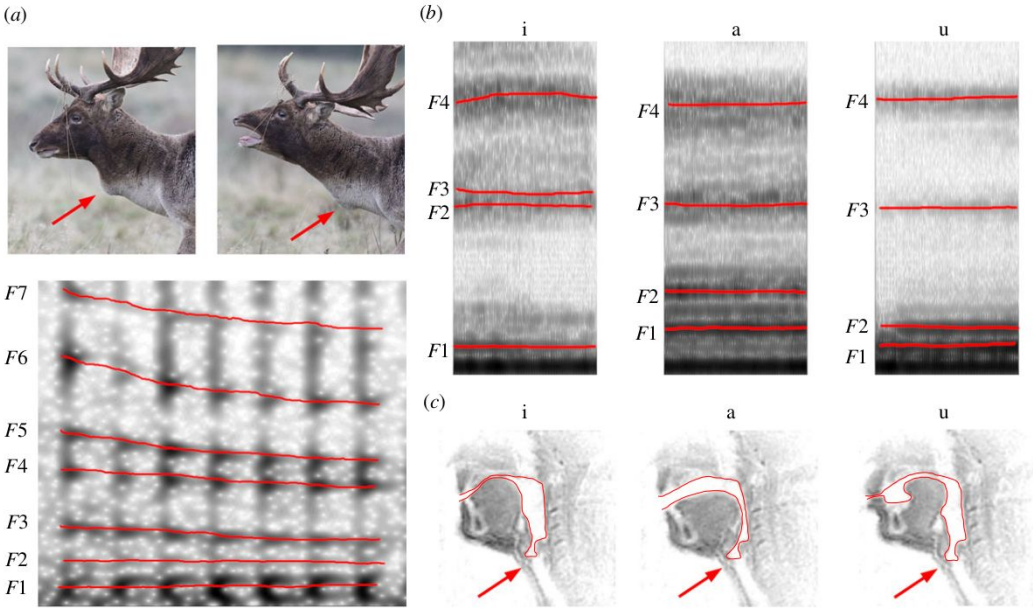
Research

Static and dynamic formant scaling conveys body size and aggression

Andrey Anikin[1,2], Katarzyna Pisanski[2] and David Reby[2]

What else #3: lazy VTL

- Articulation (vowels) vs. vocal tract elongation
- Works to some extent
- [u] > [i] or mil-mal?



PHILOSOPHICAL TRANSACTIONS B

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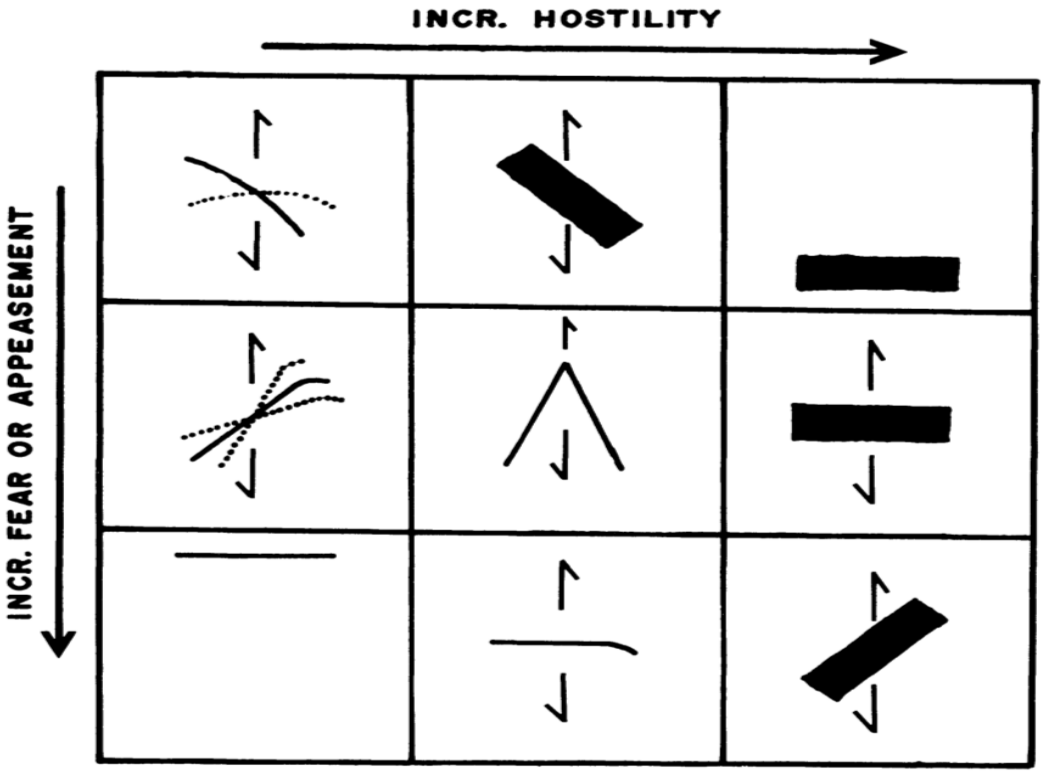
Vocal size exaggeration may have contributed to the origins of vocalic complexity

Katarzyna Pisanski[1,†], Andrey Anikin[1,2] and David Reby[1]

Morton's rules

Similar logic to within-call acoustic variation in different species

High-pitched, tonal
vs.
Low-pitched, harsh



From Morton (1977) "On the occurrence and significance of motivation-structural rules in some bird and mammal sounds"

Why loudness matters

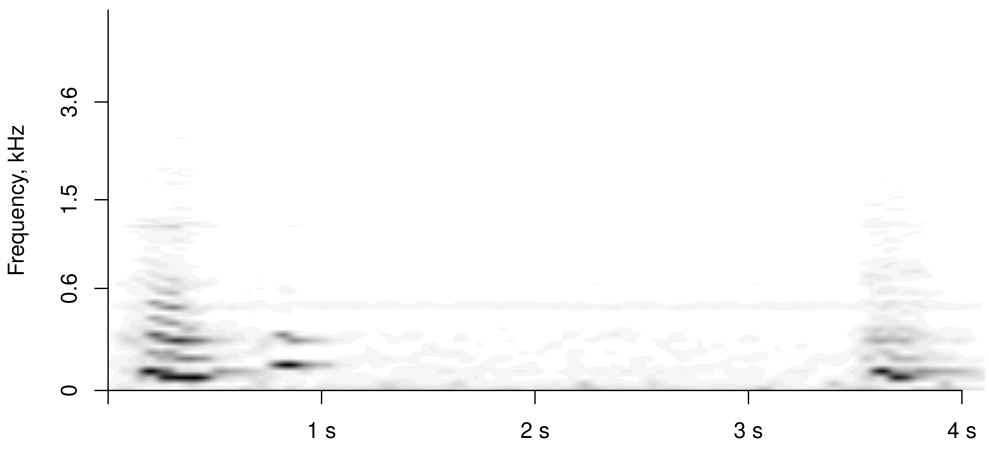
- Loud is large
- Loud is fit
- Loud is punch-ready
- Loud is harsh
- Loud is aversive and alarming

Great - let’s be low AND loud!

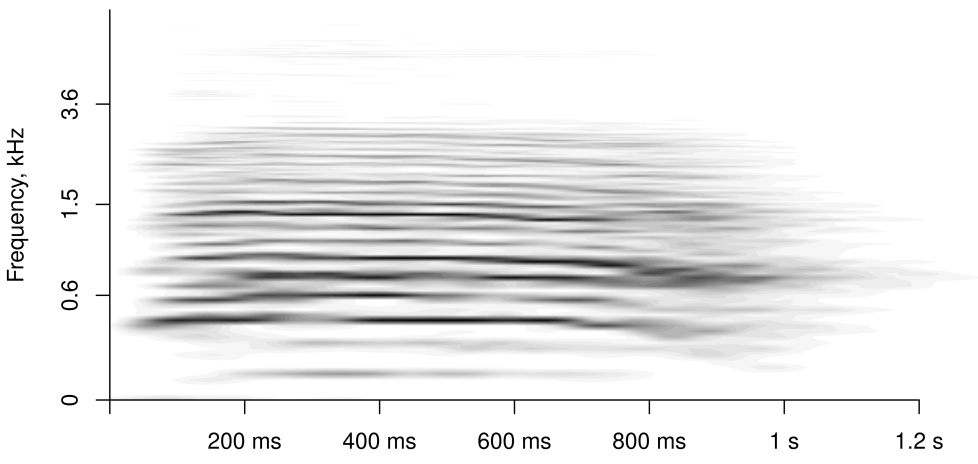
- Pitch correlates with loudness
- Open mouth -> high first formant -> [a] instead of [u]
- Thus: frequency vs. loudness tradeoff

Ex. of loudness strategy

Submissive

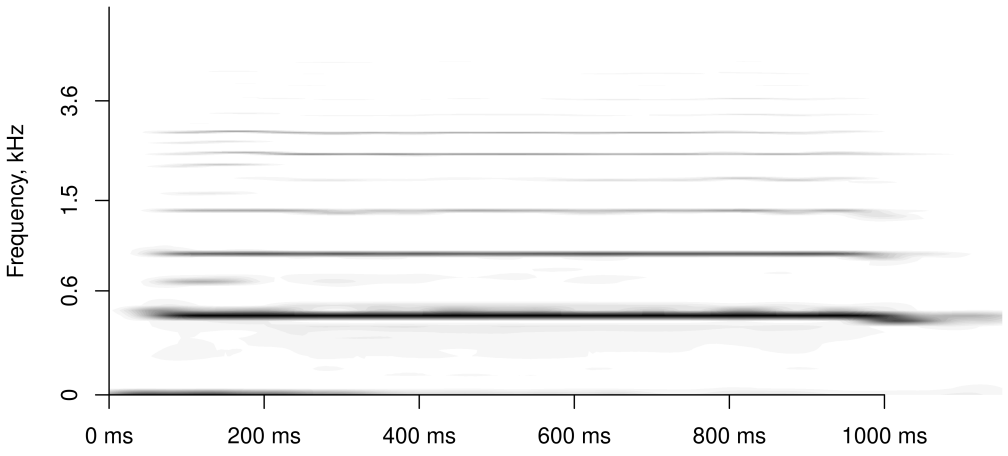


Aggressive

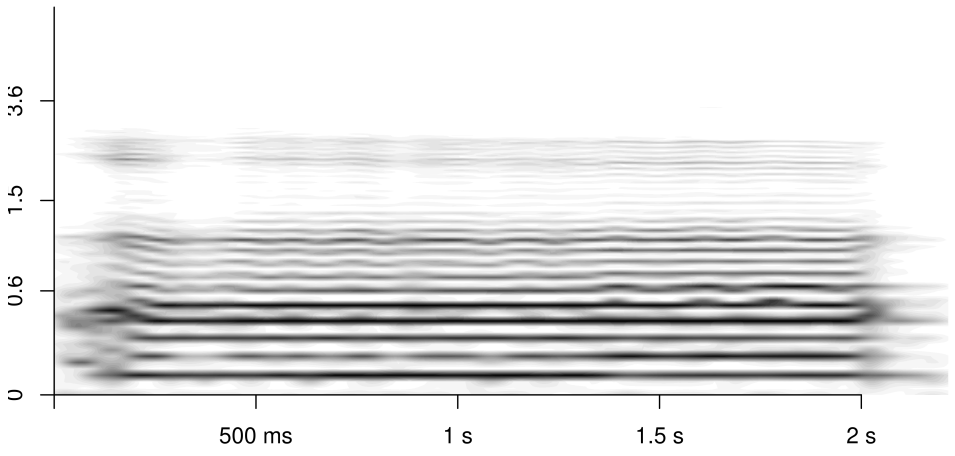


Ex. of frequency strategy

Small



Large



Conclusions from loudness study

1. Speakers “speak up” to intimidate, and it works
2. Loudness-frequency tradeoff: loud = raised pitch + wide-open mouth, so [a] not [u]
3. Loud and low together = honest index of physical formidability
4. Frequency code prioritized for size exaggeration, loudness for aggression

Anikin et al. (2023) The role of loudness in vocal intimidation. Journal of Experimental Psychology: General. https://cogsci.se/publications/2023_loud/anikin_2023_loud_preprint.pdf

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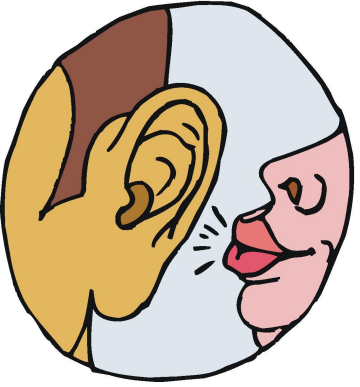
Auditory attention

Bottom-up

- Involuntary
- Stimulus-driven
- Determined by the low-level sensory property known as **salience**

Top-down

- Voluntary
- Goal-driven
- Determined by conscious intentions



Salience code hypothesis

Acoustic properties of animal/human vocalizations conveying high-intensity emotion exploit sensory biases in the auditory system

Acoustic signatures:

- Amount of stimulation (long, loud)
- Unpredictability
- High frequency

COGNITION AND EMOTION
2020, VOL. 34, NO. 6, 1246–1259
https://doi.org/10.1080/02699931.2020.1736992

OPEN ACC

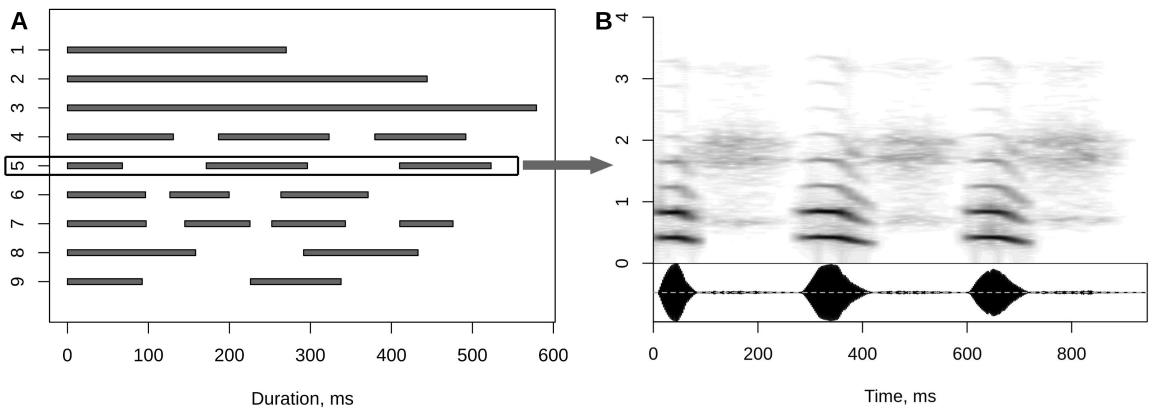
The link between auditory salience and emotion intensity

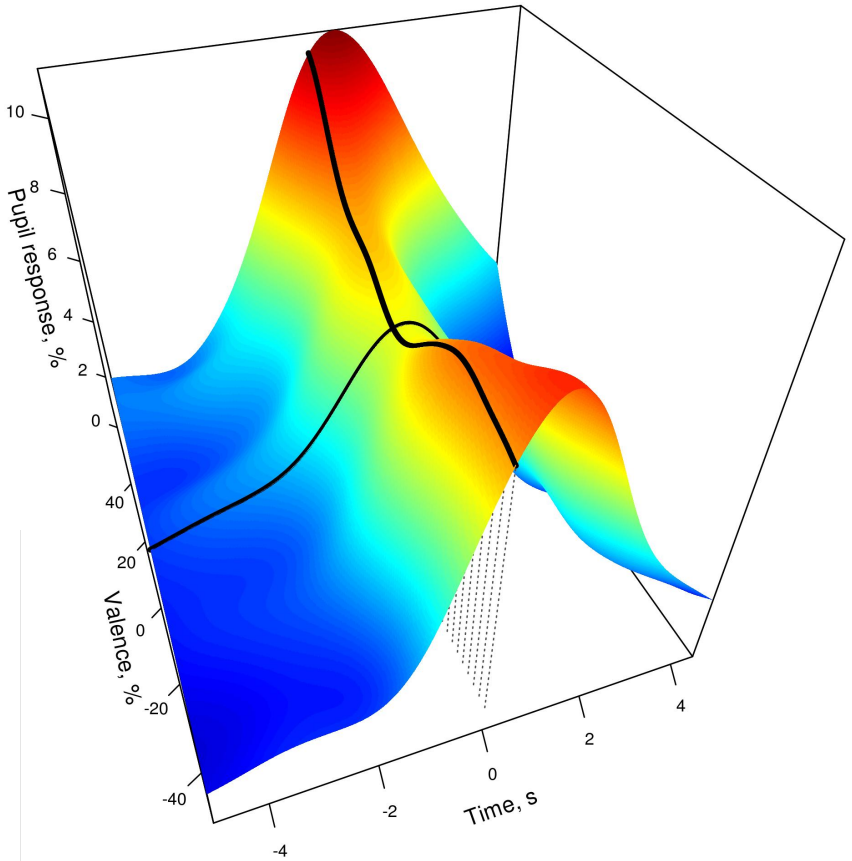
Andrey Anikin

Division of Cognitive Science, Lund University, Lund, Sweden

Follow-up on salience code

- Use physiological measures of arousal
- Test predictions from salience literature
- Apply to specific acoustic characteristics (eg temporal structure)

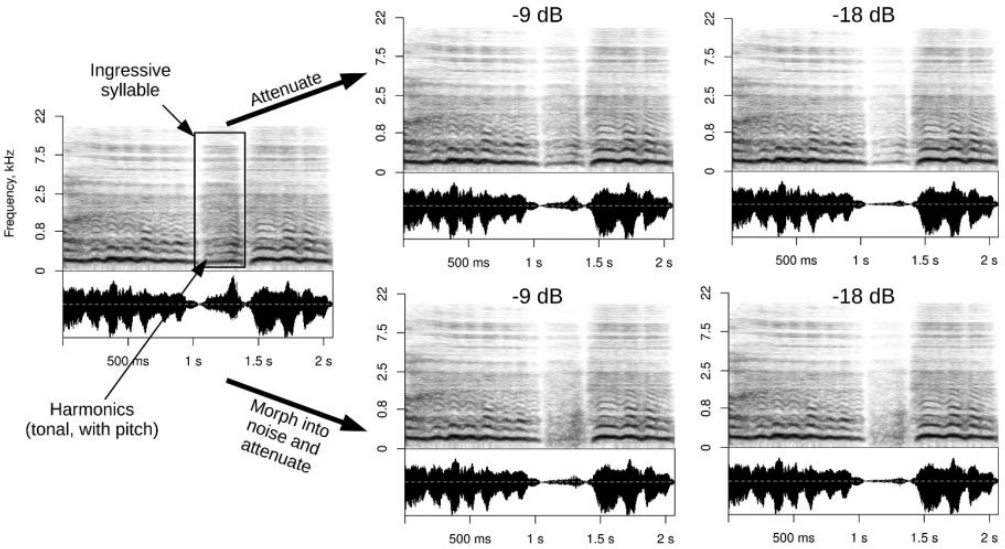


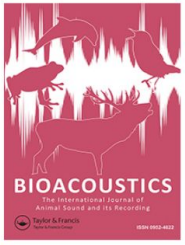


Oliva & Anikin, 2018

Done so far: ingressive phonation

- Ingressiveness signals arousal in laughs, cries, moans
- %time vocalizing?





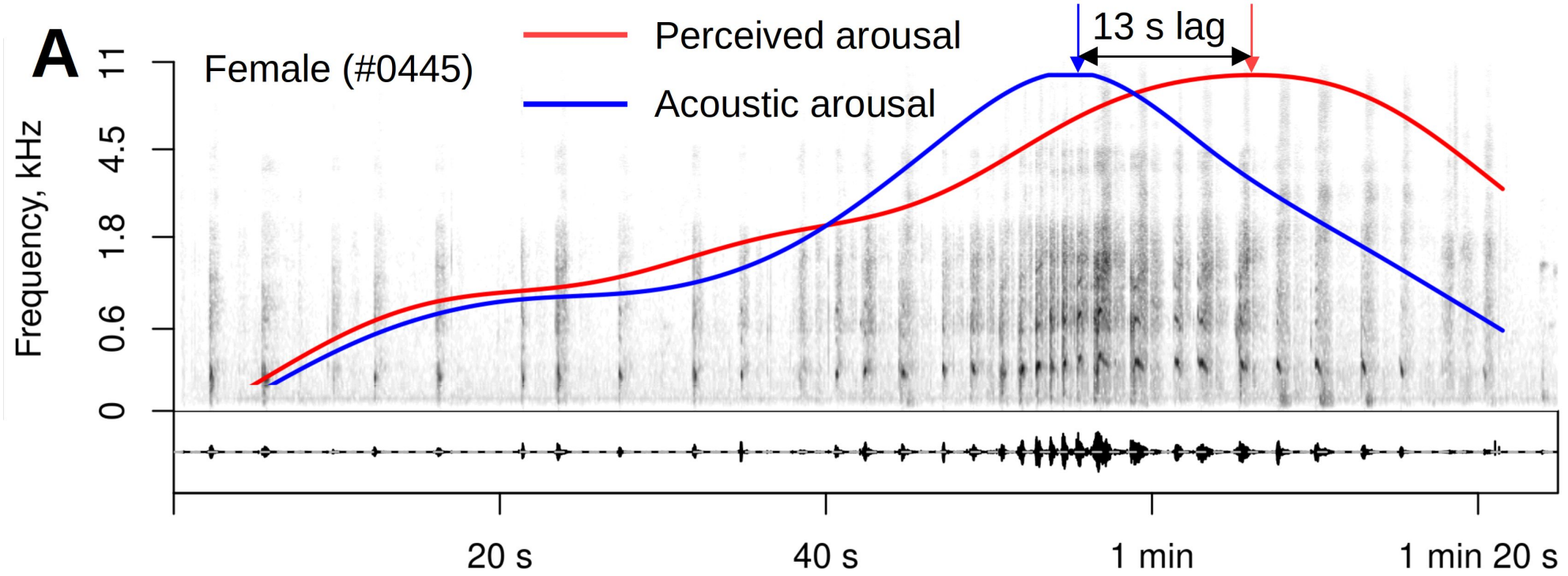
Bioacoustics
The International Journal of Animal Sound and its Recording

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tbio20

Ingressive phonation conveys arousal in human nonverbal vocalizations

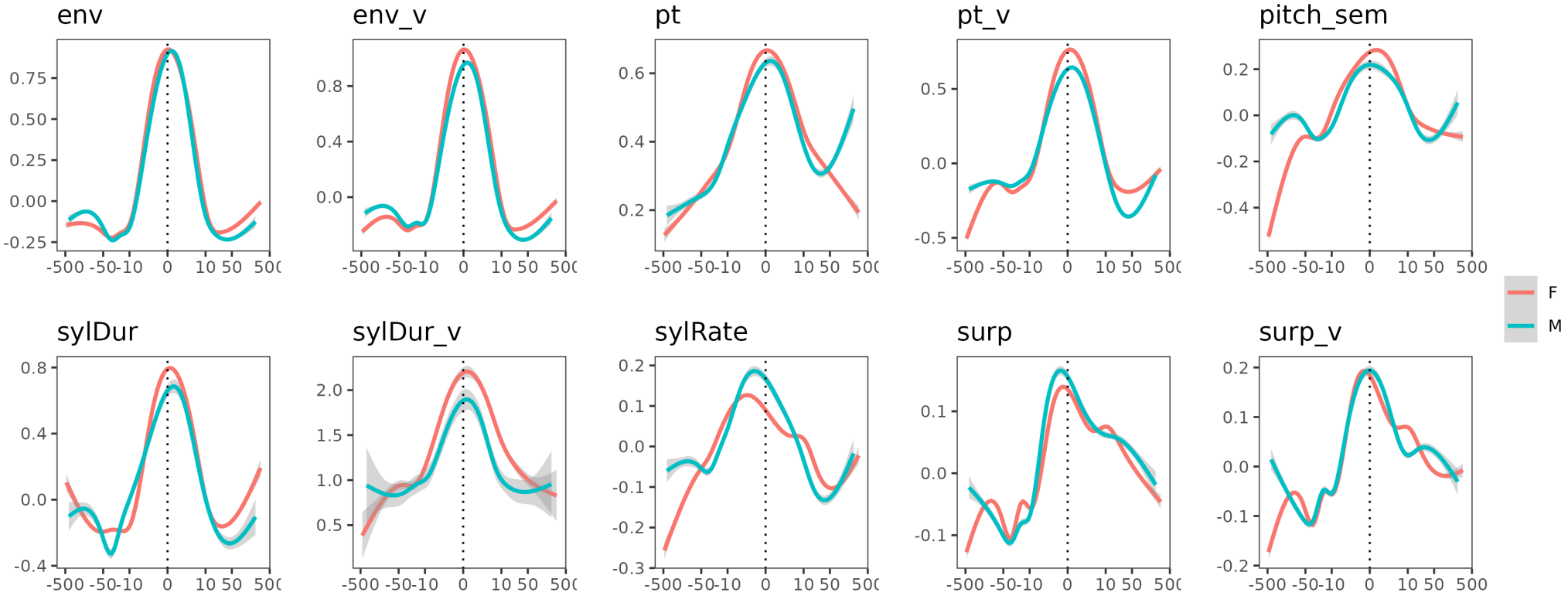
Andrey Anikin & David Reby

Done so far: surprisal in moans



Anikin (2023) Why do people make noises in bed?
https://osf.io/preprints/psyarxiv/3t9gd

Done so far: surprisal in moans



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The esthetics of voice

- Index of fitness (like everything)
- Good for regulating approach-avoidance behavior

Ex. 1: the ugly

- Task: develop the scariest possible train alarm for keeping wildlife off railroad tracks
- Approach: synthetic sounds with unpredictable nonlinearities
  - prevent habituation
  - intrinsically aversive

Ex. 2: the best & worst languages

PNAS RESEARCH ARTICLE | PSYCHOLOGICAL AND COGNITIVE SCIENCES

Do some languages sound more beautiful than others?

Andrey Anikin[a,b], Nikolay Aseyev[c], and Niklas Erben Johansson[d,1]

Edited by Kenneth Wachter, University of California, Berkeley, CA; received October 29, 2022; accepted March 25, 2023

Italian is sexy, German is rough—but how about Páez or Tamil? Are there universal phonesthetic judgments based purely on the sound of a language, or are preferences attributable to language-external factors such as familiarity and cultural stereotypes? We collected 2,125 recordings of 228 languages from 43 language families, including 5 to 11 speakers of each language to control for personal vocal attractiveness, and asked 820 native speakers of English, Chinese, or Semitic languages to indicate how much they liked these languages. We found a strong preference for languages perceived as familiar, even when they were misidentified, a variety of cultural-geographical biases, and a preference for breathy female voices. The scores by English, Chinese, and Semitic speakers were weakly correlated, indicating some cross-cultural concordance in phonesthetic judgments, but overall there was little consensus between raters about which languages sounded more beautiful, and average scores per language remained within ±2% after accounting for confounds related to familiarity and voice quality of individual speakers. None of the tested phonetic features—the presence of specific phonemic

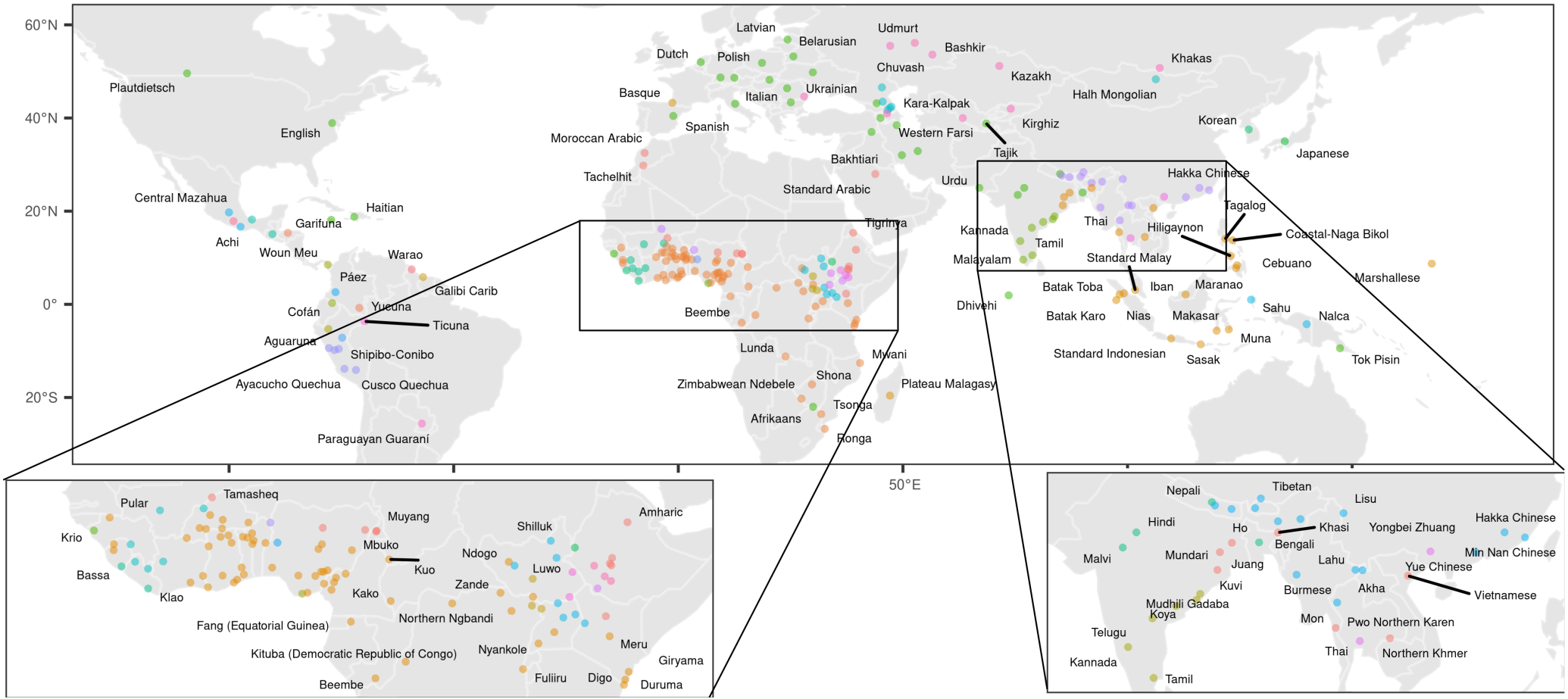
Significance

Despite the abiding popular interest, there is hardly any empirical research on whether some languages sound more beautiful than others and whether some phonetic features are universally attractive. We carefully controlled for language familiarity and cultural biases in the first large-scale, cross-cultural

Tolkien and movie villains

Mooshammer et al. (2022) The influence of the mother tongue on the perception of constructed fantasy languages.

Sampled languages



How to get data on a budget

https://live.bible.is/jesus-film/eng

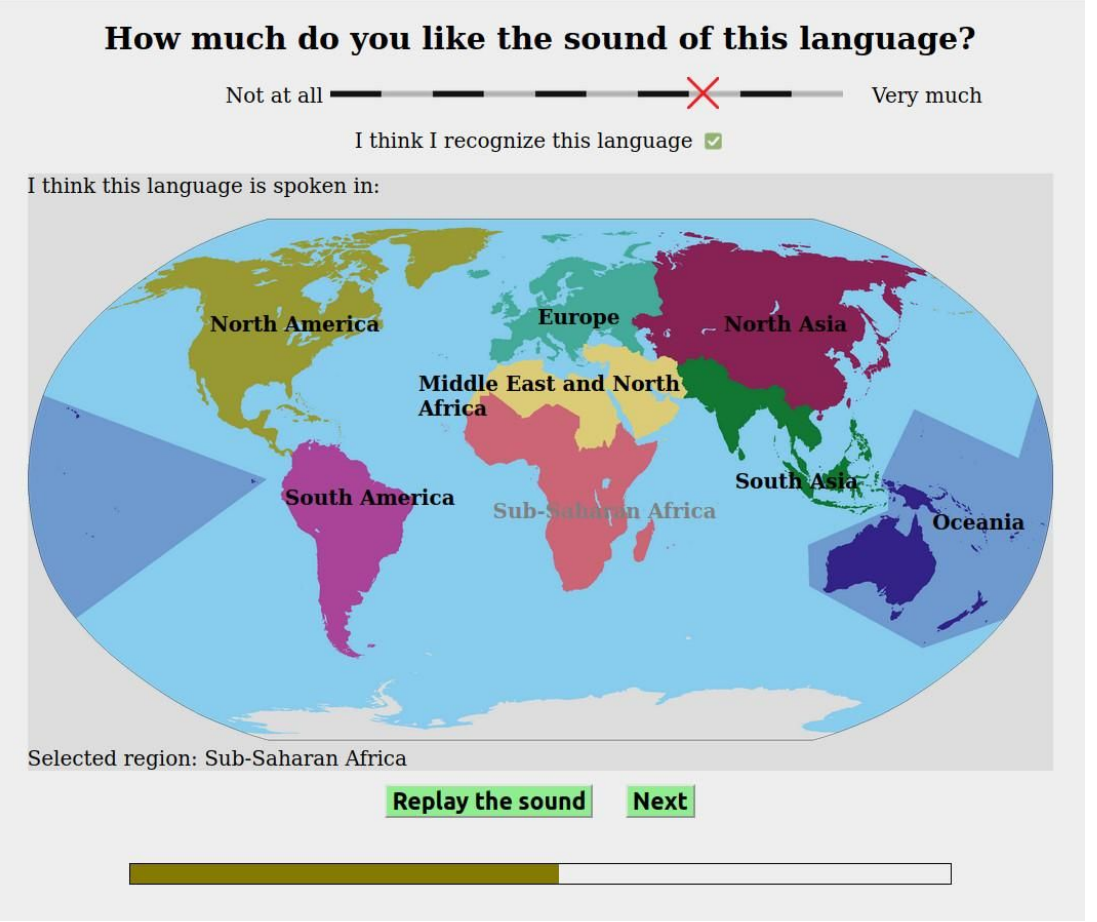
Audio samples

- 2125 clips from 228 languages
- 11 scenes (clips) per language
- 5 – 19 s / clip, so ~1-2 min / language
- normally 11 different voices (M + F)

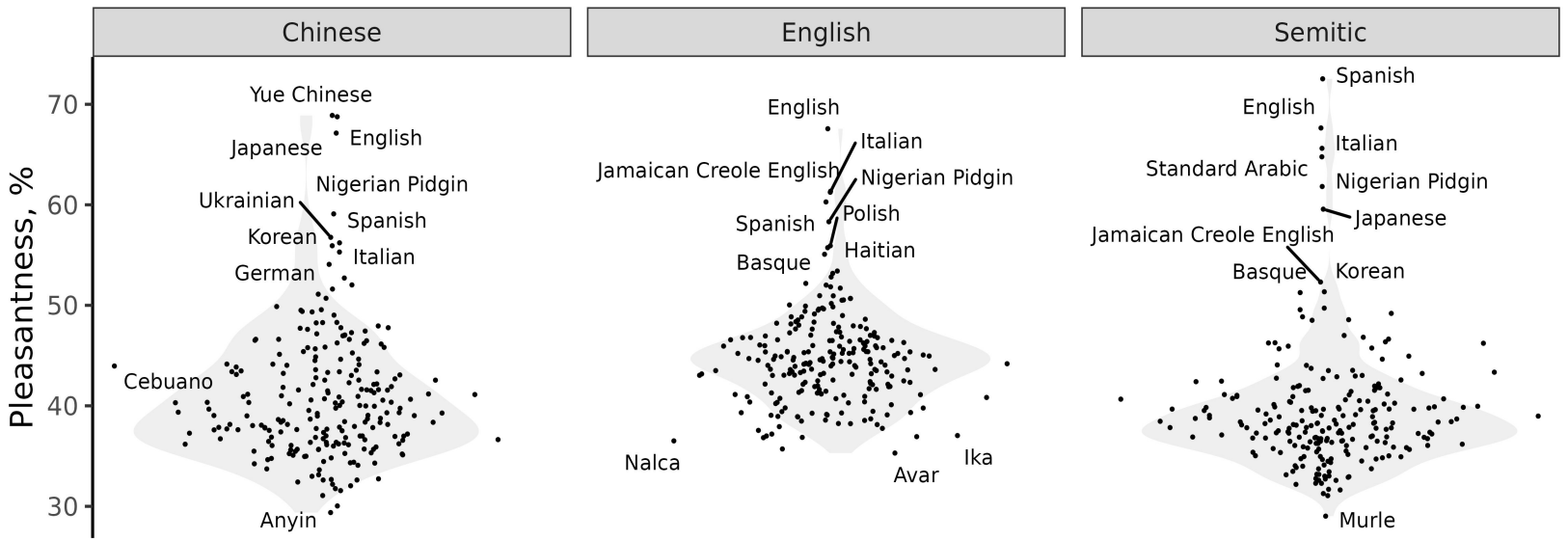
Perceptual experiment

Raters = 820 native speakers of:

- English
- Chinese
- Semitic languages



Raw ranks



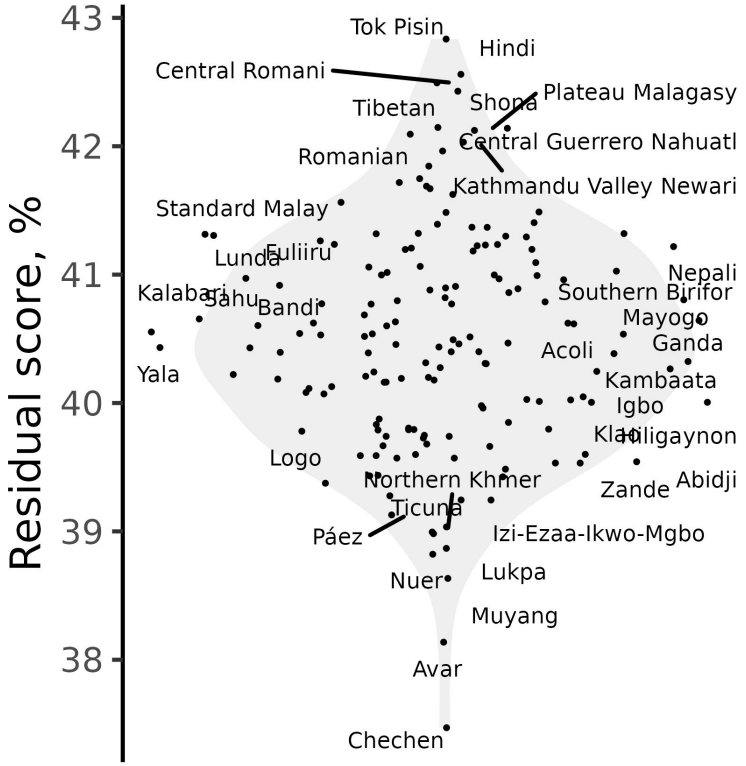
Really beautiful
(Nigerian pidgin)

Not so beautiful
(Nalca, Indonesia)

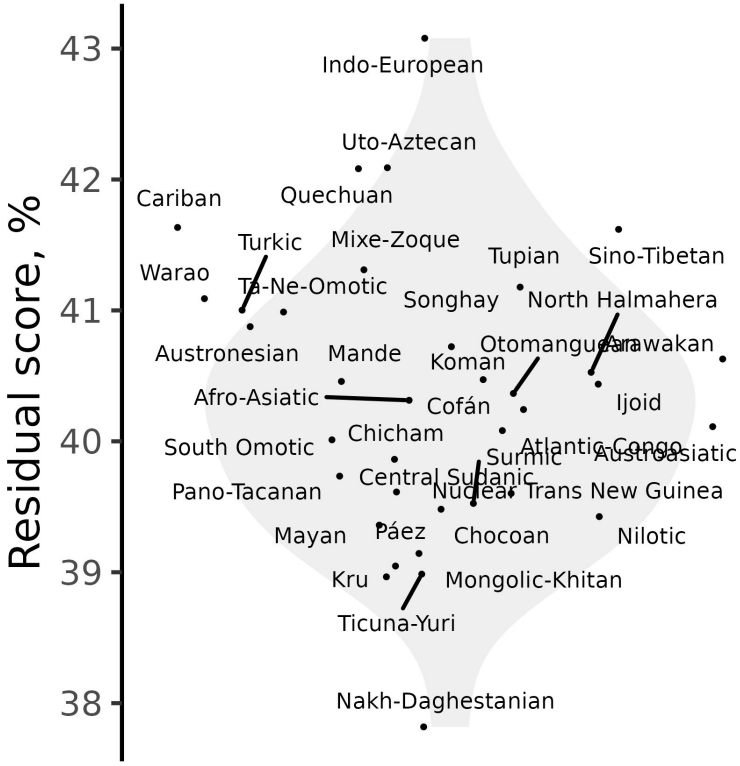
Why?
Familiarity, speaker's voice, cultural stereotypes, similarity to L1, universal phonetic preferences, ...

Controlling for familiarity and acoustics

Languages



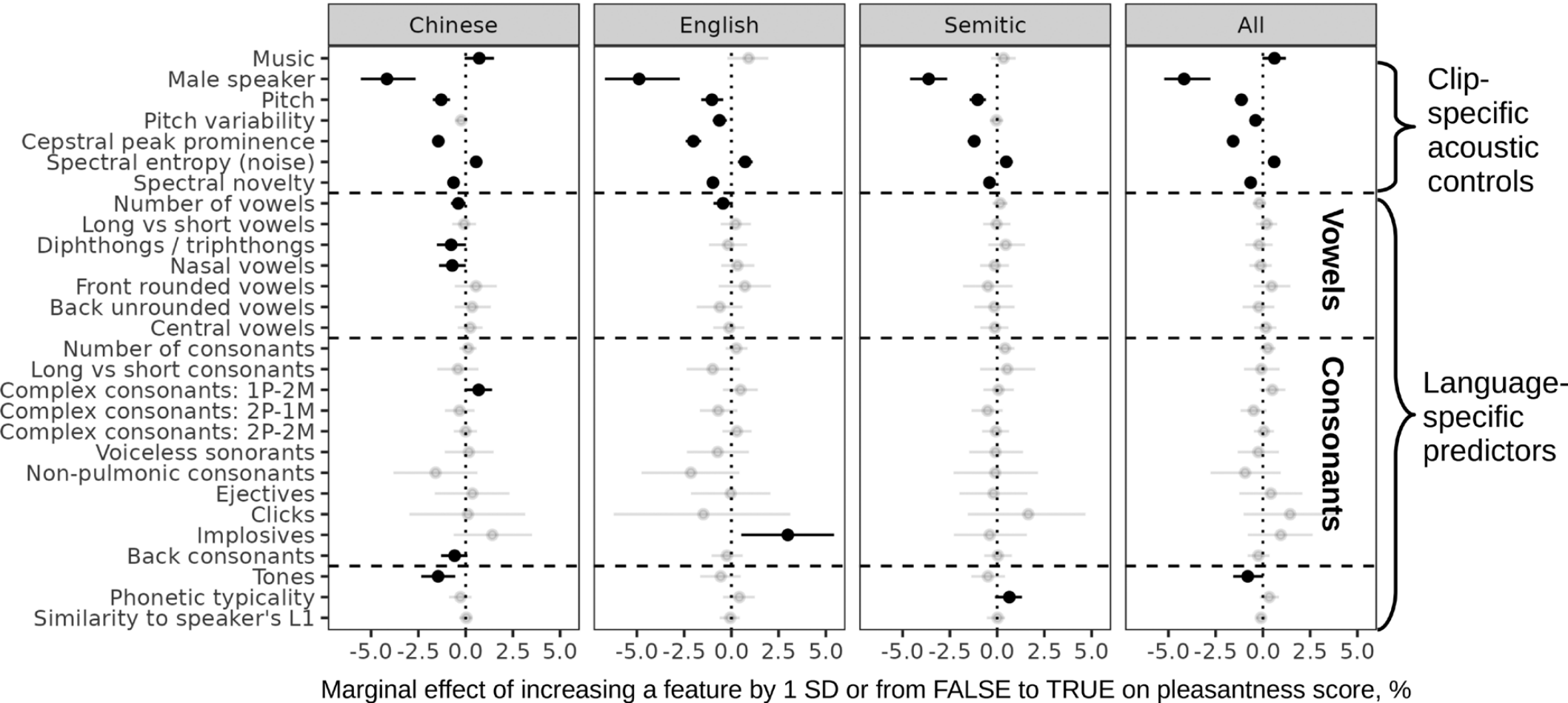
Families



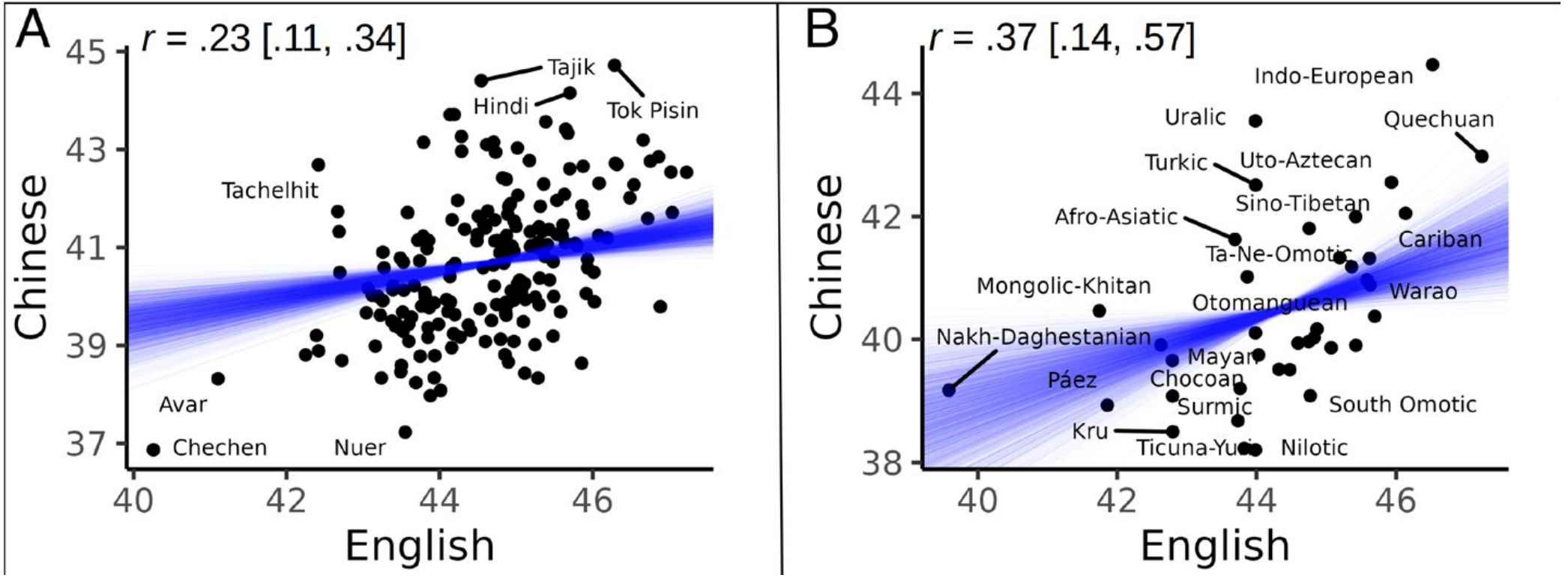
Really beautiful
(Hindi)

Not so beautiful
(Chechen)

Acoustic predictors of preferences?



Cross-cultural agreement?



...in the ear of the beholder?

- Population preferences for voices, familiarity +
- Personal preferences for specific languages +
- Population preferences for specific languages ±
- Population preferences for phonetic features -
- Negative outliers (= Mooshammer 2022)

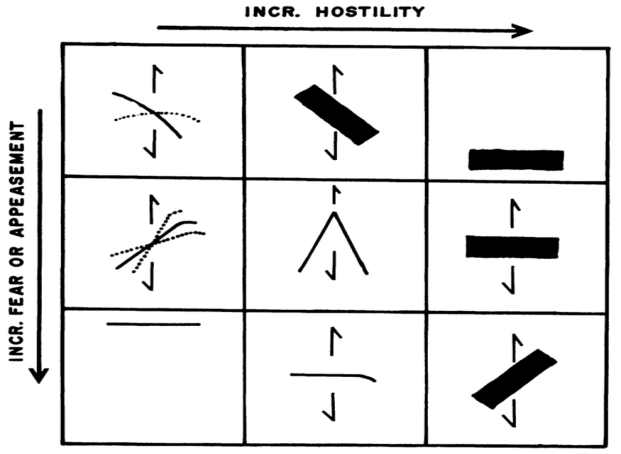
Limitations, follow-ups

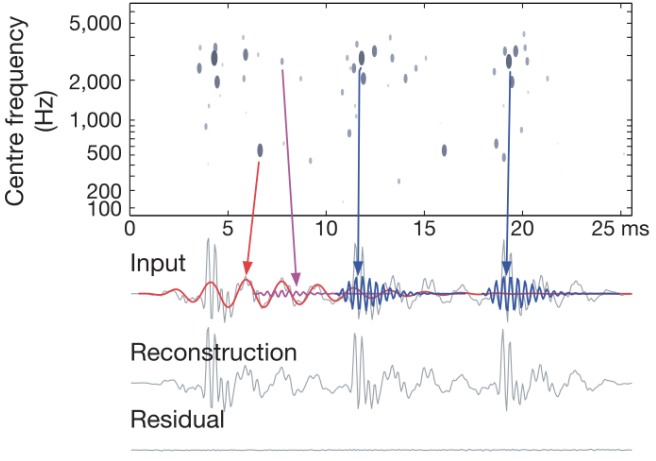
- Taken from a religious film ≠ natural speech?
- Need >10-15 s per clip?
- Need phonetic transcription of each recording?
- Targeted acoustic manipulation --> effect on pleasantness

Recap

The ***WHY***s of acoustic code

- Cross-modal correspondences --> Morton's rule
- Processing biases of the auditory system --> acoustic markers of emotion intensity / arousal
- ...?

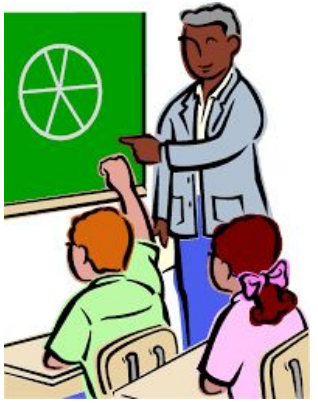




Morton 1977; Smith & Lewicki 2006

Benefits

- Generally applicable (speech, nonverbal human & animal vocalizations)
- Solid foundation in evolution and cognition (mitigates the risk of overfitting uncertain acoustic measurements)
- Easy to teach & remember



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Thank you!

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