Tone Perception in Rural Mexico: Cultural Expectations and Speech Theory

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How does our experience with language influence our ability to tell certain sounds apart?

'*fan*' [fæn] vs. '*van*' [væn]

'*thin*' [θɪn] vs. '*fin*' [fɪn]

Not all sounds are equally distinguishable. Why?

Questions

1. Does your language background help you to better tell sounds apart?
2. Do speakers of a language with linguistic tone hear pitch better than speakers of a language without tone?
3. How do such findings fit within speech theory?

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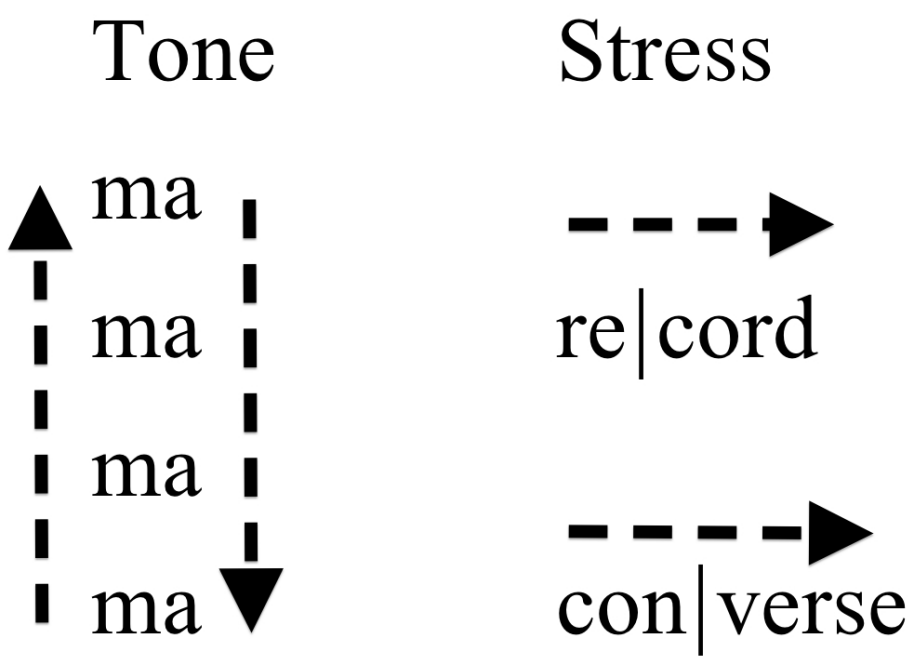
Tone and Stress

Languages can be divided into '*stress*' and '*tone*' languages.

English word	Stress	Mandarin word	Tone	Meaning
record	1^{st} syllable	ma	high level	'*mother*'
re**cord**	final syllable	ma	high rising	'*hemp*'
sing	only syllable	ma	falling rising	'*horse*'
red	only syllable	ma	high falling	'*scold*'

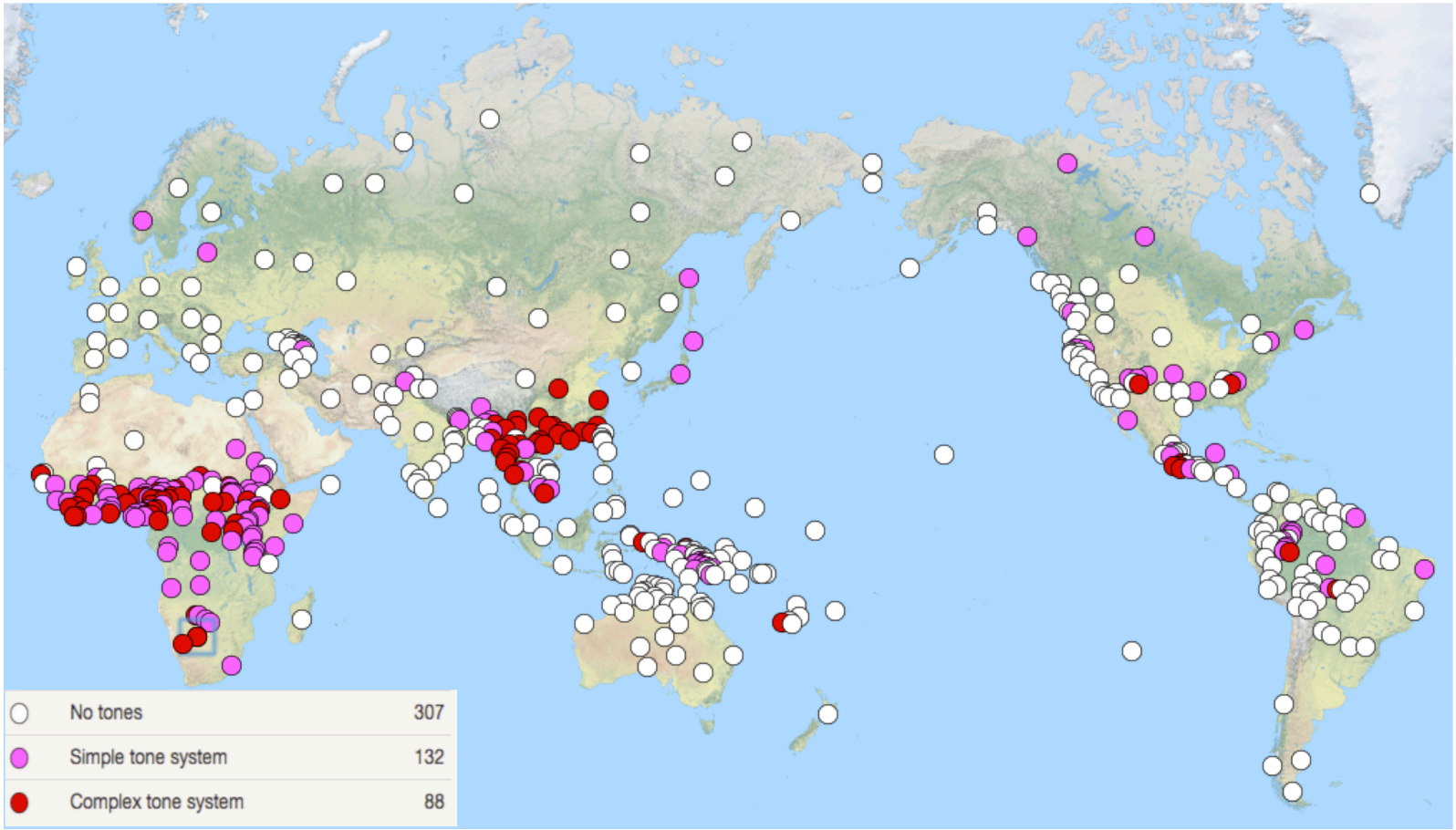
What are we hearing?

We distinguish both stress and tone using **pitch**. Though we listen for different things in each type of language.



Languages

Roughly 50% of the world's languages are tonal.



(Maddieson, 2011)

Southern Mexico and tone

The largest family of languages in the Americas, Oto-Manguean, have very complex tone languages. They are spoken in Southern Mexico and comprise 177 different languages.

Itunyoso Trique

One such Oto-Manguean language with a complex tonal system is *Itunyoso Trique*, spoken in Oaxaca, Mexico by about 2,500 speakers (DiCanio, 2008, 2010, 2012a,b,c).

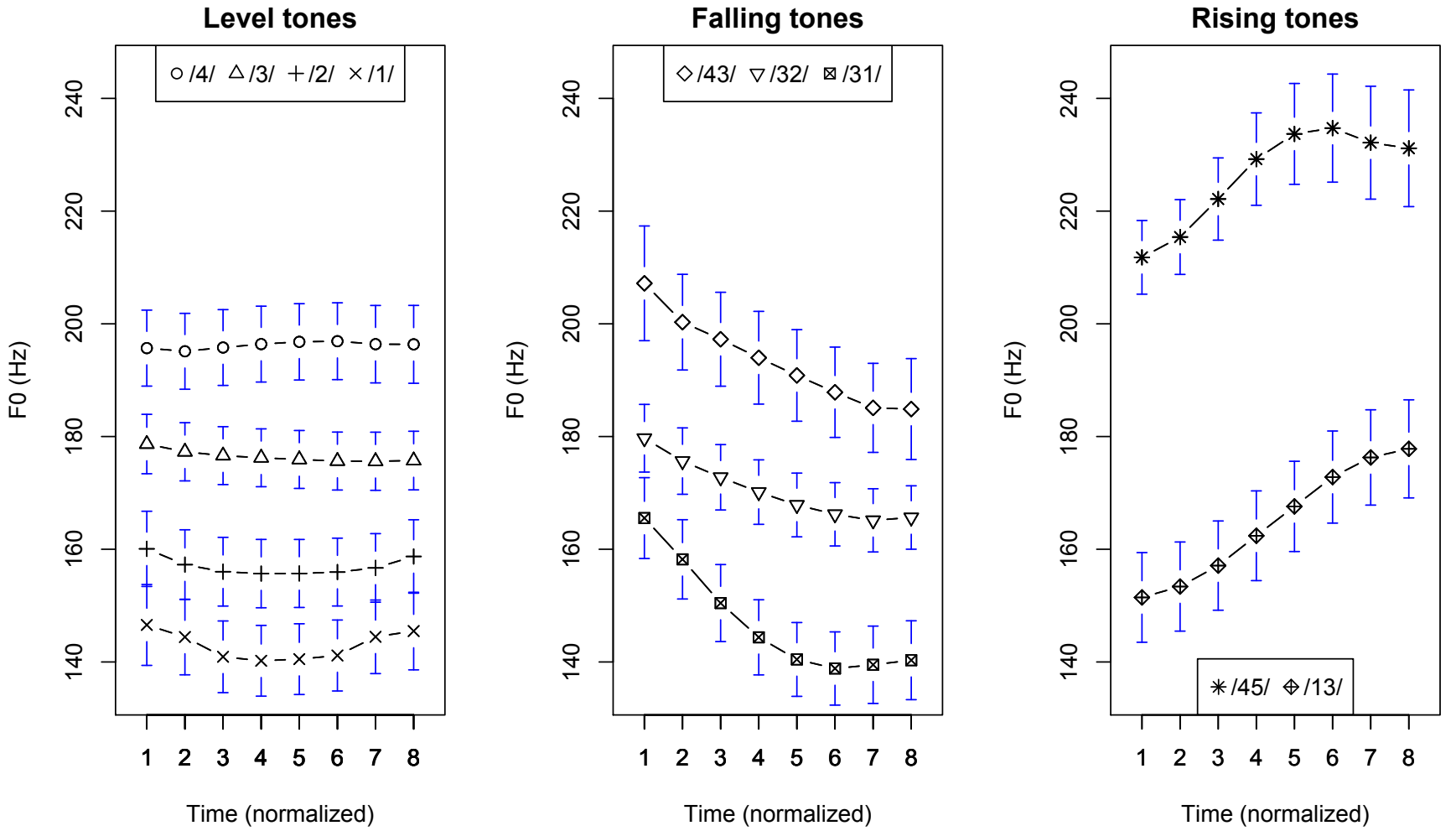
There are **nine** tones in Trique, including level, falling, and rising tones (DiCanio, 2008).

Tone	IPA	Gloss	Tone	IPA	Gloss
4	ββe^{4}	'*hair*'	43	li^{43}	'*small*'
3	nne^{3}	'*plough*'	32	nne^{32}	'*water*'
2	nne^{2}	'*to lie (tr.)*'	31	nne^{31}	'*meat*'
1	nne^{1}	'*naked*'	45	yoh^{45}	'*my forehead*'
			13	yo^{13}	'*light, quick*'

Numbers are used to mark tone, as if it were a musical scale, with "1" being lowest and "5" highest.

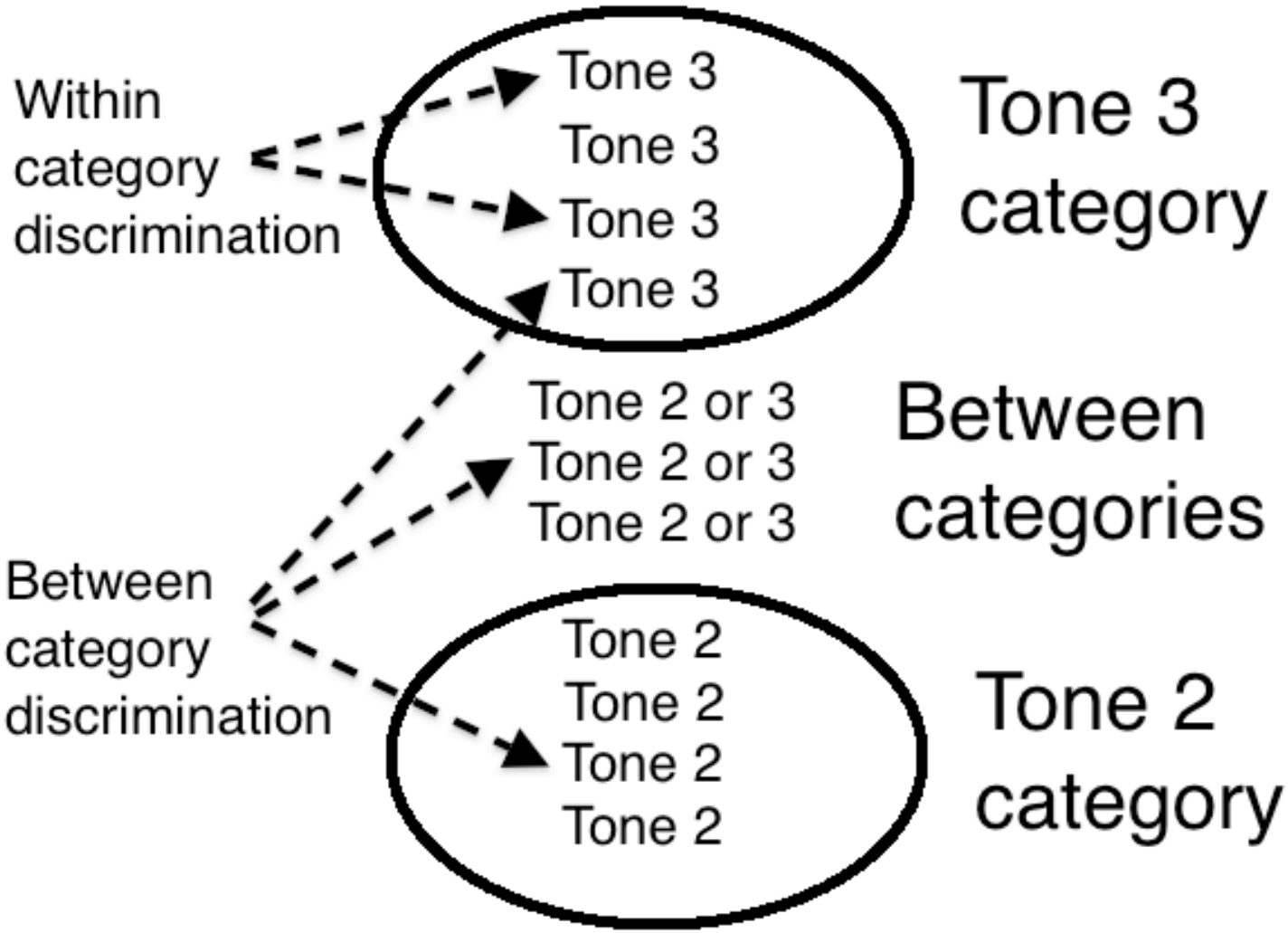
Trique tones (DiCanio, 2008)

Trique tones are distinguished by pitch level and the degree of movement.



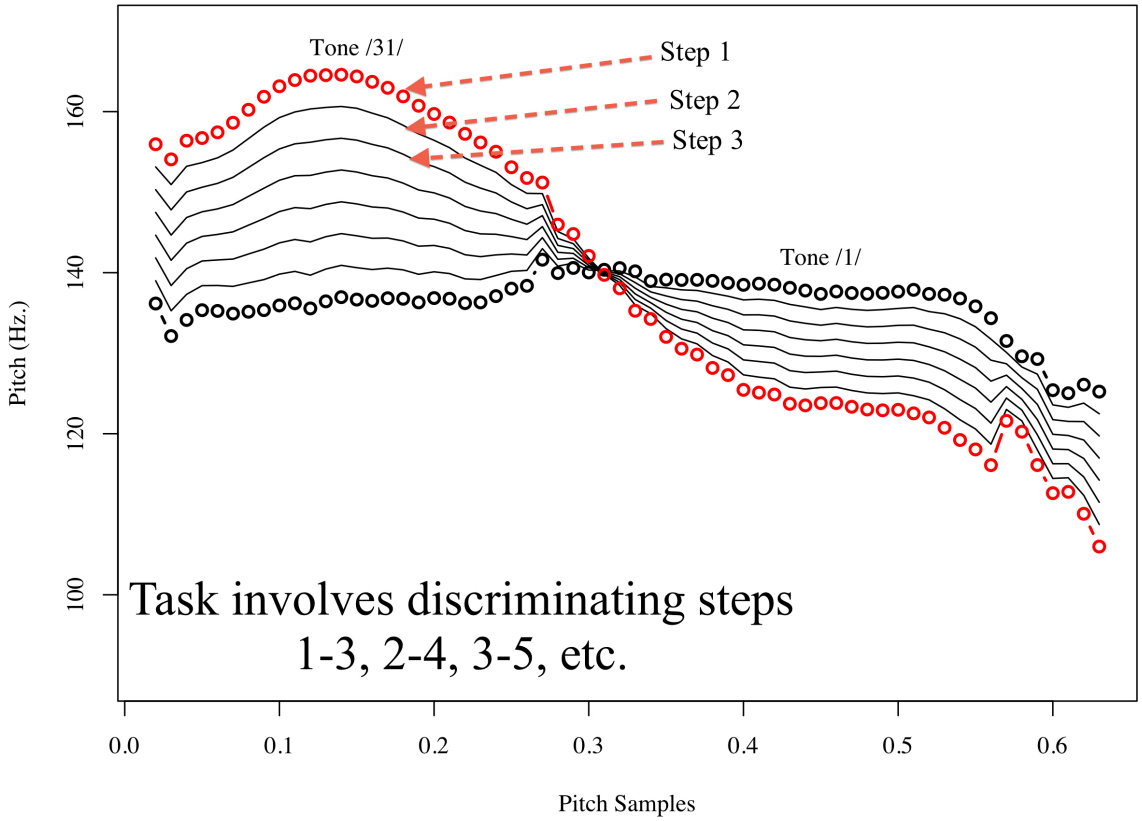
Are speakers of tone languages better at hearing pitch than speakers of non-tonal languages?

- Yes, speakers of tonal languages (Mandarin Chinese, Cantonese, Thai) are better at discriminating tonal contrasts than speakers of non-tonal languages (English, German) (Burnham et al., 1996; Lee et al., 1996; Hallé et al., 2004; Peng et al., 2010; So, 2006).
- Mandarin Chinese listeners are *worse* at discriminating pitch than English listeners, but only *within* categories, not between them Stagray and Downs (1993).
- What about Trique tone?

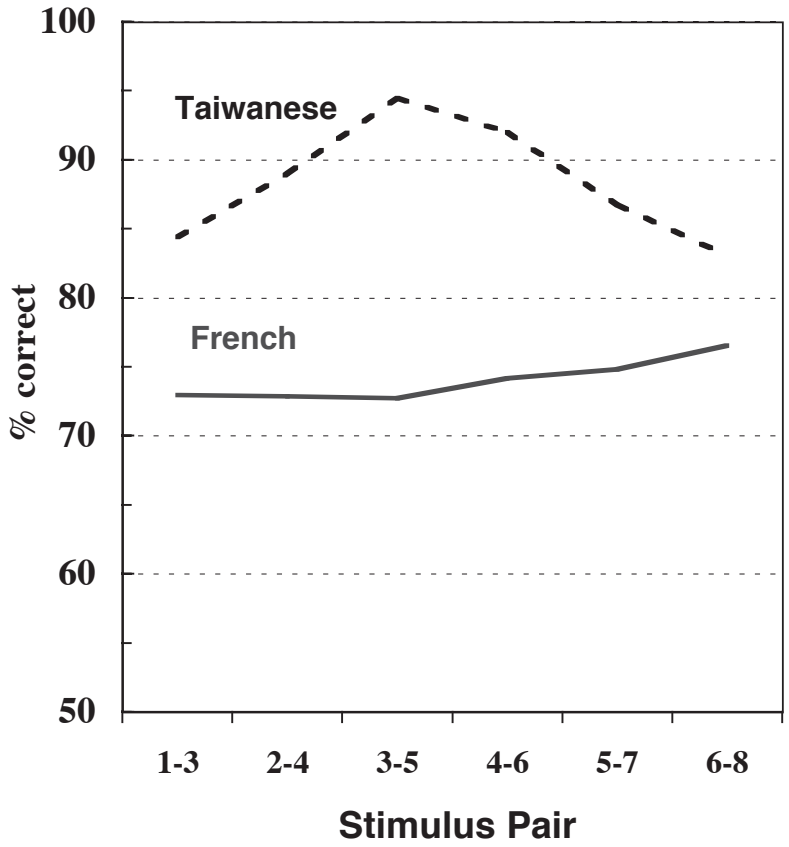

Within
category
discrimination
Tone 3
Tone 3
Tone 3
Tone 3
Tone 3
category
Tone 2 or 3
Tone 2 or 3
Tone 2 or 3
Between
categories
Between
category
discrimination
Tone 2
Tone 2
Tone 2
Tone 2
Tone 2
category

Method for experiment

Play Trique tonal pairs to native Trique listeners and to native French listeners. French is non-tonal. E.g. /nne^{31}/ 'meat' vs. /nne^{1}/ 'naked';
Resynthesized speech

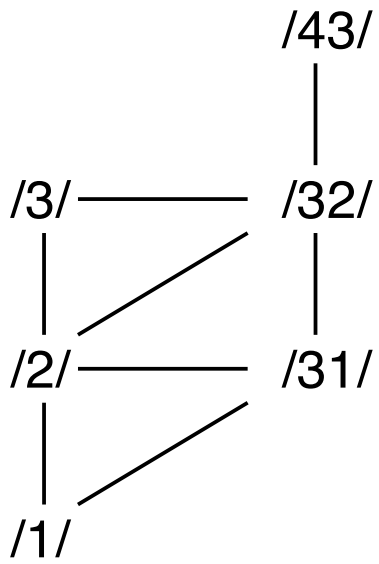


Given a continuum from tone A to tone B (changing F_0), native listeners are better at discriminating *between* category stimuli than *within* category stimuli. Figure from Hallé et al. (2004).



Discrimination Task

Resynthesized pitch on tokens using 8 steps for each tonal pair (Praat (Boersma and Weenink, 2013), Matlab). Tokens were matched for duration.

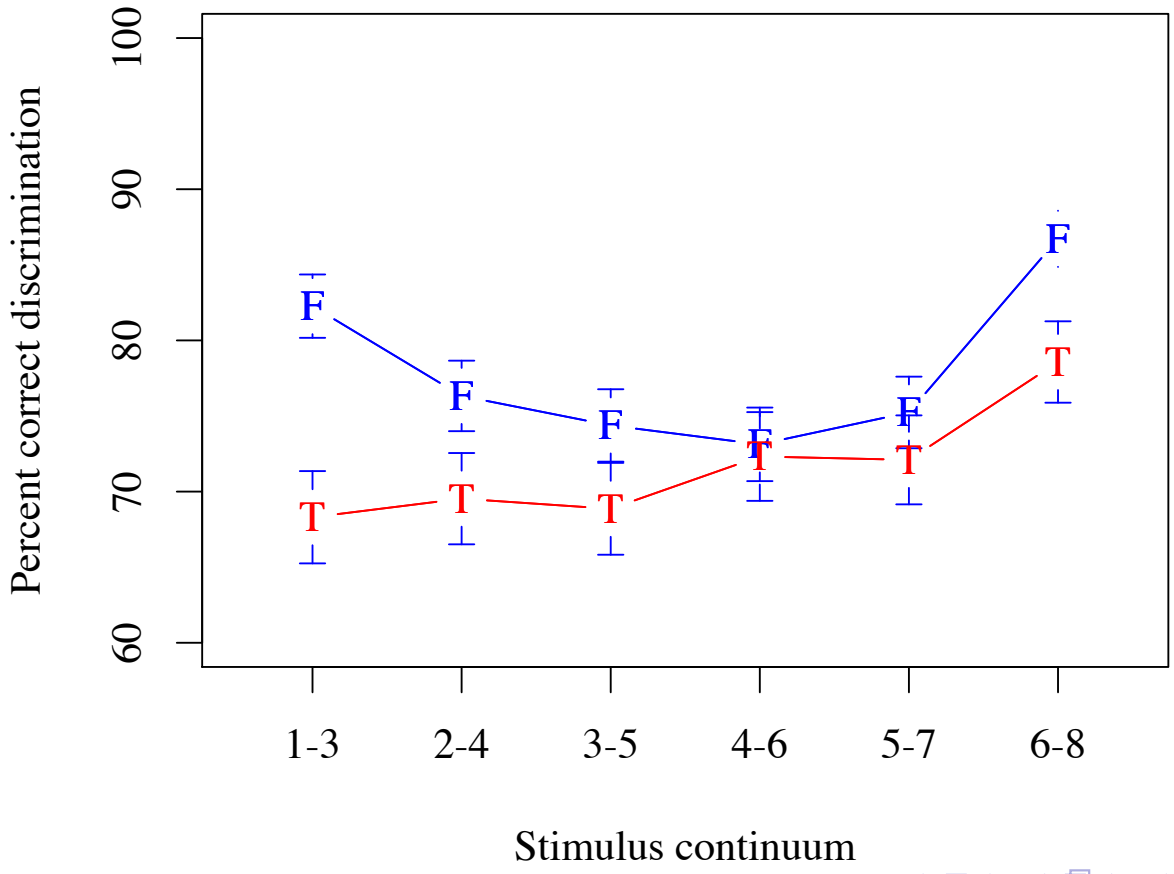


Experimental design

- 8 Blocks of 48 trials preceded by 1 practice block of 32 trials.
- All tonal stimuli appeared in carrier sentence:
  ka^3 *tah*^{3} <target> , 'He says <*target*>.'
- Subjects: 18 native speakers of Itunyoso Trique (all bilingual Trique-Spanish), 20 native speakers of French.
- Location: Oaxaca, Mexico and Lyon, France. Experiment run in Spanish or French by author.
- Followed methods in Hallé et al. (2004).

Results

French speakers performed better (78.0%) overall at tonal discrimination than Trique speakers (71.6%).



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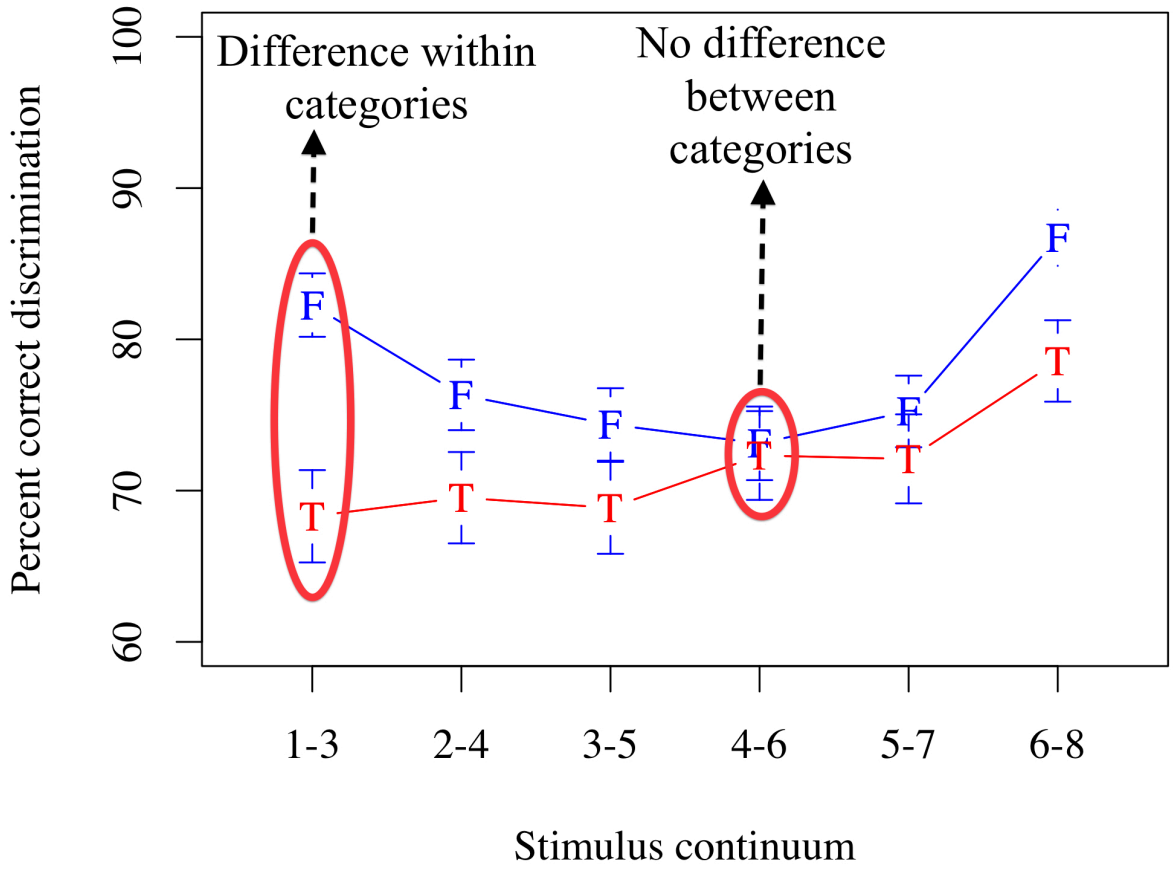
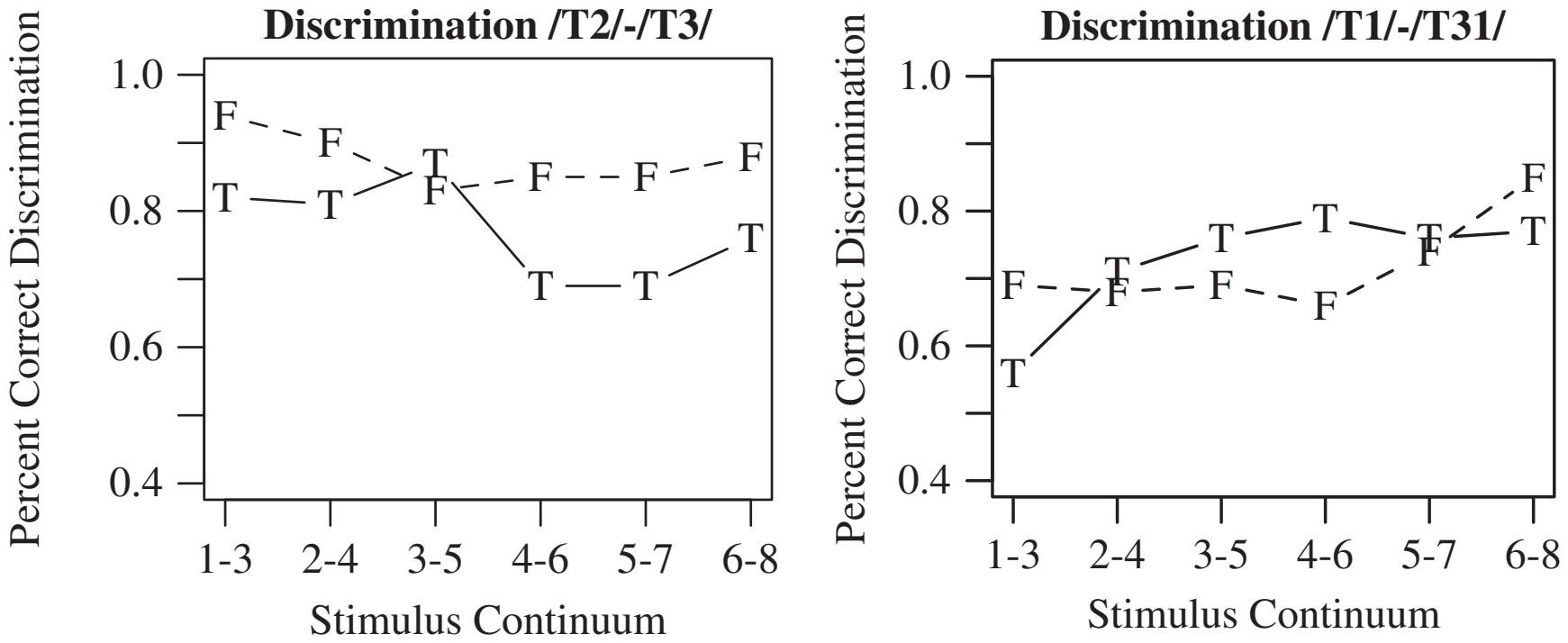


Specific tonal comparisons



At the continuum endpoints, Trique listeners are poorer at discriminating stimuli than French listeners. At the midpoints, they improve.

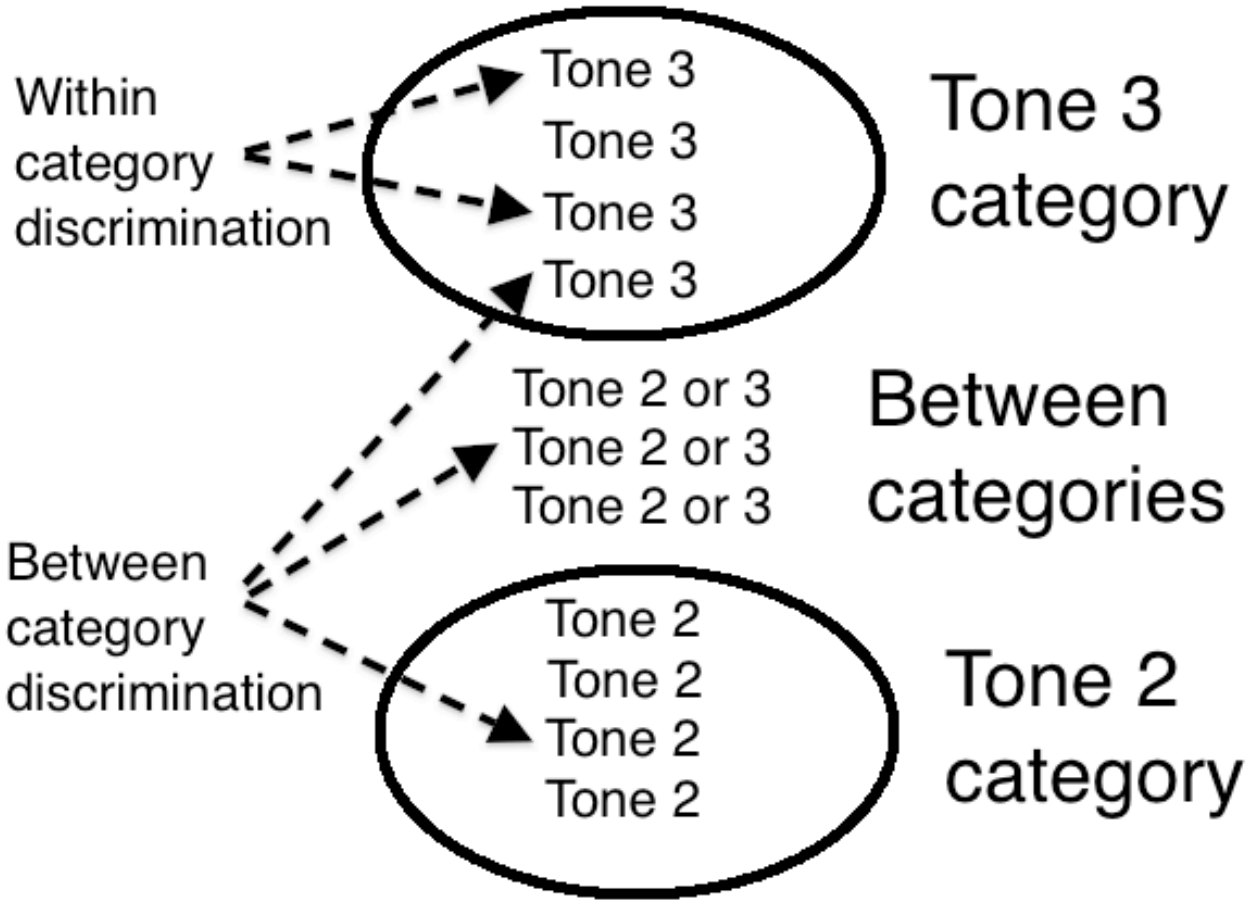
Discussion

Overall, French listeners are better at discriminating between stimuli with different pitch patterns. However, they are also *less sensitive* to what these pitch patterns mean.

Trique listeners are as good as French listeners at distinguishing pitch when doing so distinguishes words in the language.

However, they seem to ignore non-meaningful pitch differences, in line with Stagray and Downs (1993), but contra Burnham et al. (1996); Hallé et al. (2004); Peng et al. (2010).

Trique listeners are better at between category discrimination because the *linguistic boundaries* are here.

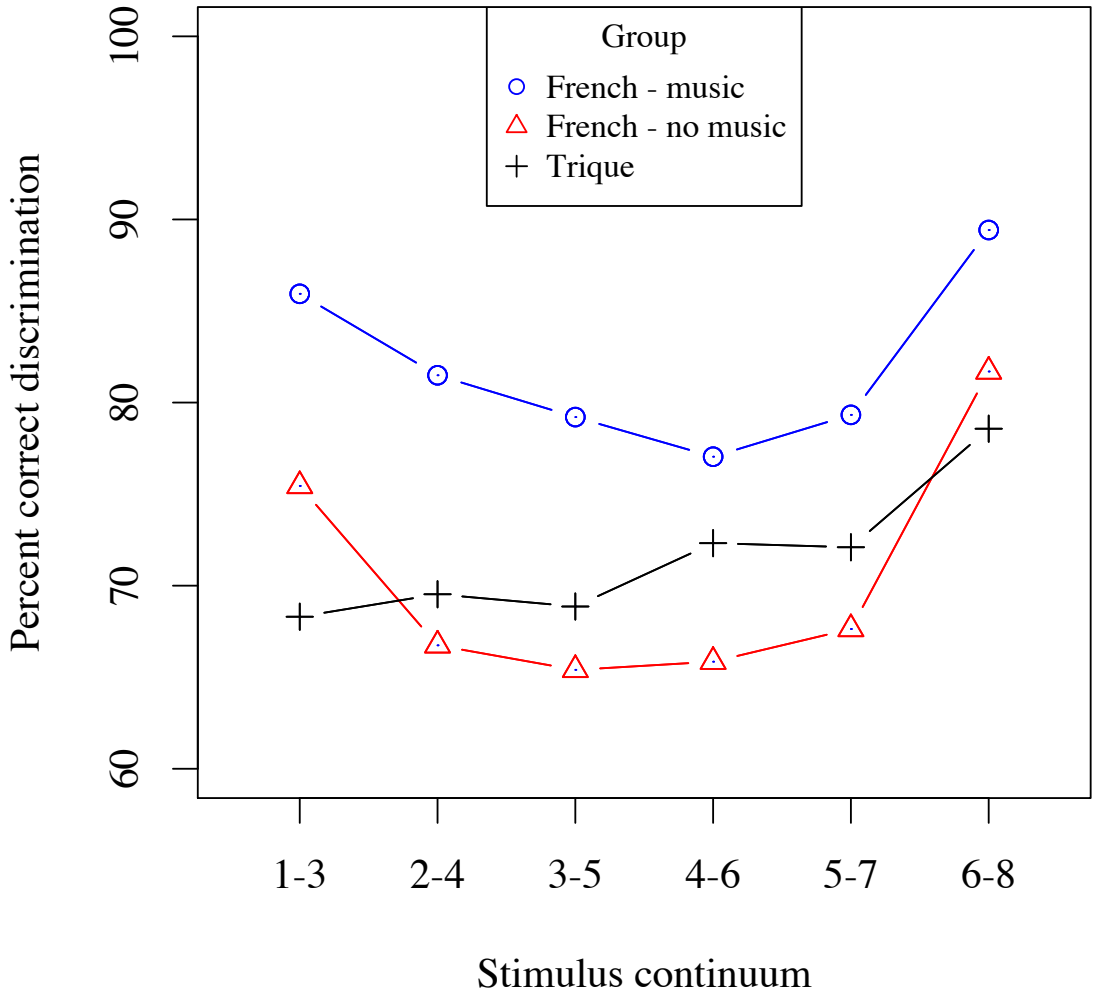


But if so, why haven't others found this?

Some hypotheses:

- Unlike Mandarin, Thai, and Cantonese speakers, there is no literacy in Trique.
- Moreover, Trique subjects are not familiar with experimental tasks. Unfamiliarity with experimental procedures may explain some of the language differences in discrimination accuracy. In some studies, psychologists are potential subjects (Peng et al., 2010).
- Most studies do not control for music experience, which influences one's ability to perceive tone (Deutsch et al., 2009).
- While many of the French subjects (13/20) had some music training, such training is rare for Trique listeners.

French listeners without music training (70.5%) perceive tone similarly to Trique listeners (71.6%). Musically-trained French listeners do well (82.1%)



The studies which found better pitch perception for tone language listeners did not specifically examine whether native tone language listeners had a music background.

Yet, the exception, Stagray and Downs (1993), involved listeners who specifically *had no musical experience*.

More recent work where listeners had no musical experience found little effect of tone language background on pitch discrimination (So and Best, 2010).

Discussion

- Even if we control for musical training, French and Trique listeners *still* look similar. Why might this be?
- Potential bias of Trique listeners toward linguistic meaning in the experiment.
- Instead of responding to the question "do these two stimuli *sound* different?" in the experiment, listeners may be answering a different question; "do these two stimuli sound like different *words*?".
- The former question investigates *metalinguistic* knowledge, while the latter investigates pure linguistic knowledge.

Conclusions

- Speaking a tone language does not improve one's ability to discriminate pitch, but musical training appears to play a role, as may one's familiarity with metalinguistic experimental designs.
- However, speaking a tone language *does* tune your ears to better distinguish ambiguous tonal pairs.
- Cultural and educational expectations play a role in perceiving tone.

Future Directions

- Examine how Trique tone is produced in larger context of narratives and folklore.
- Examine how the grammatical uses of tone influence native speakers production and perception of tone.

Acknowledgements

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Thank you!

Psychoacoustic Effects

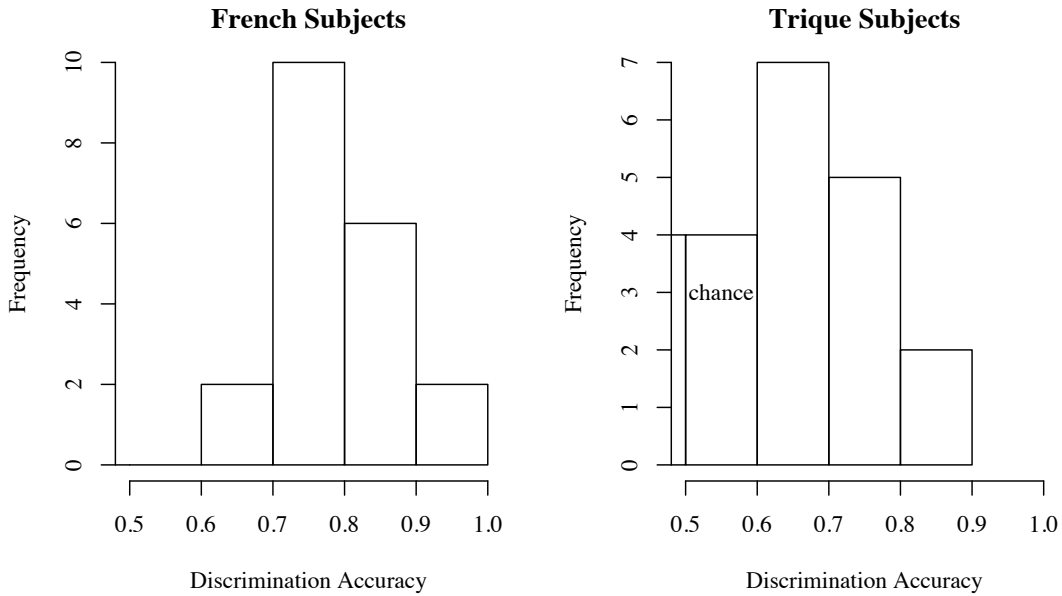
- Post-hoc analyses revealed a correspondence between the raw psychoacoustic distance between each stimulus pair and the degree of discriminability by listeners.

- Psychoacoustic distance between stimuli = average difference in semitones between each stimulus pair.
- Worst discriminated tonal pairs are among those most psychoacoustically similar.

Tonal Comparison	Psychoacoustic Distance (semitones)	Discrimination Accuracy Trique	French
/32/ - /31/	1.02	71.6%	87.2%
/2/ - /3/	0.81	72.3%	87.5%
/43/ - /32/	0.75	58.5%	71.1%
/2/ - /32/	0.64	69.1%	81.1%
/2/ - /31/	0.63	77.4%	83.4%
/1/ - /31/	0.58	67.1%	72.0%
/2/ - /1/	0.46	60.6%	74.2%
/3/ - /32/	0.25	61.0%	67.2%

Speaker Differences

- Strong subject effect in discrimination for all tonal comparisons, mean $G^2(36) = 171.1$, $p < .001$ ***.
- Language effects on discrimination partly explainable by differences among individual listeners.



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