Tone language experience and melody perception

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Outline

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Language–Music Interaction

- It's difficult to explain all of these at once, so I focus on a salient test case.
- A set of perceptual learning theories provide a framework for predictions.

Music→Language

- Music aptitude predicts phonological processing[a] and L2 learning ability.[b]
- Prosodic deficits in amusia[c]
- Musicianship enhances lexical tone perception.[d]

[a] Anvari et al. (2002); Milovanov et al. (2007)
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Language→Music

- Direction of tritone paradox[a]
- Higher occurence of absolute pitch among tone language speakers[b]
- Better melodic memory by tone language speakers[c]

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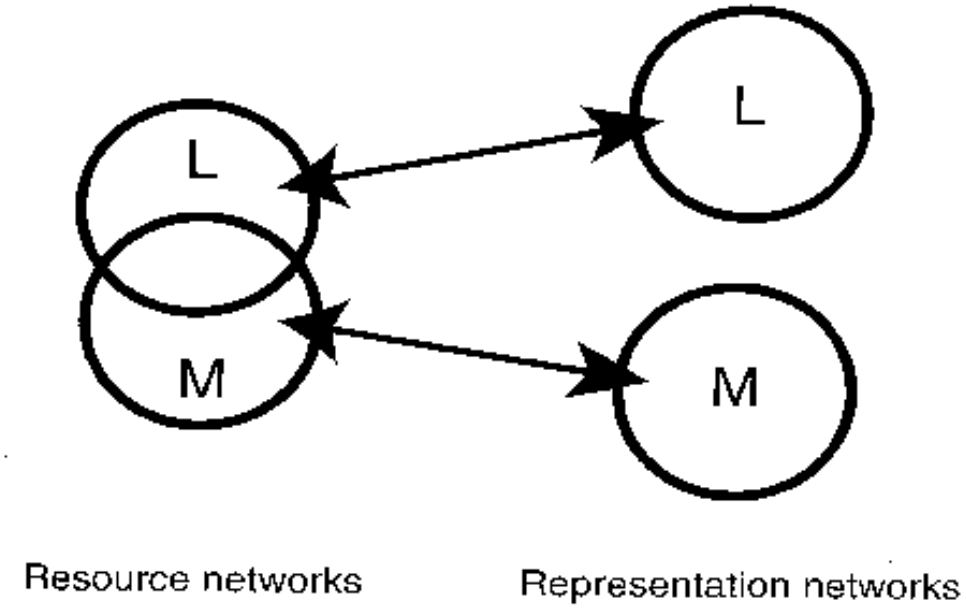
Shared Sound Category Learning Mechanism Hypothesis (SSCLMH)

Patel (2008)

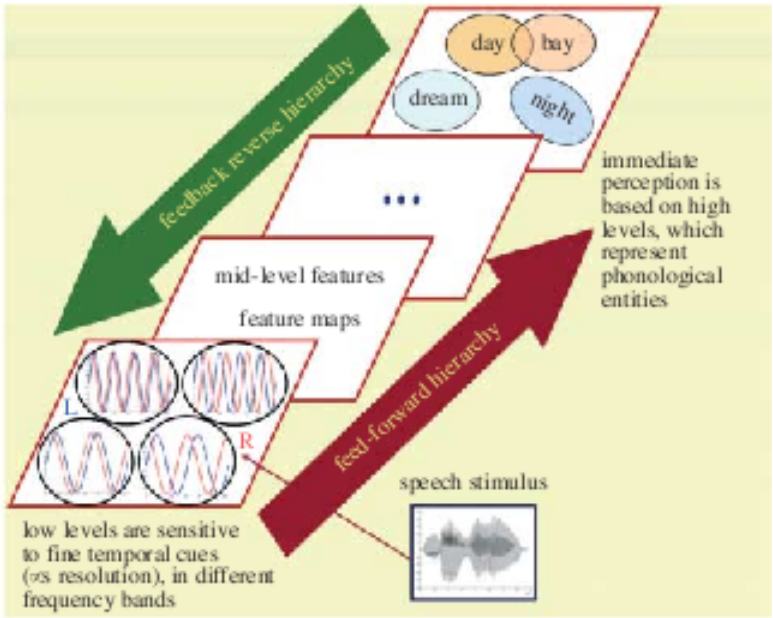
- Music and language share auditory processing resources and learning mechanisms.
- Representations of units and rules for each system are separate.



Reverse Hierarchy Theory (RHT)

Ahissar et al. (2009)

- Learning begins at the highest level which can solve a task.
- Feedback tunes inputs relevant to task.
- Tuned resources are then available to other tasks drawing on same inputs.



What sensory resources are shared by lexical tone and melody?

- SSCLMH and RHT are consistent with the observation that language–music crossover effects tend to be *specific*, rather than *general* enhancements of pitch processing.
- Each domain tunes only those inputs relevant to its task, so crossover to the other domain should include only these perceptual properties.
- Musicians tend to be like tone language speakers in certain ways, and *vice versa*.
- But what are the relevant pitch properties of language and music which are tuned?

tone	melody
height	*key*
direction	*contour*
slope	*interval*

- This is tested by comparing the perception of each melodic subcomponent by speakers of tone and nontone languages.
  1. Comparison of tone and nontone L1 speakers on melody perception
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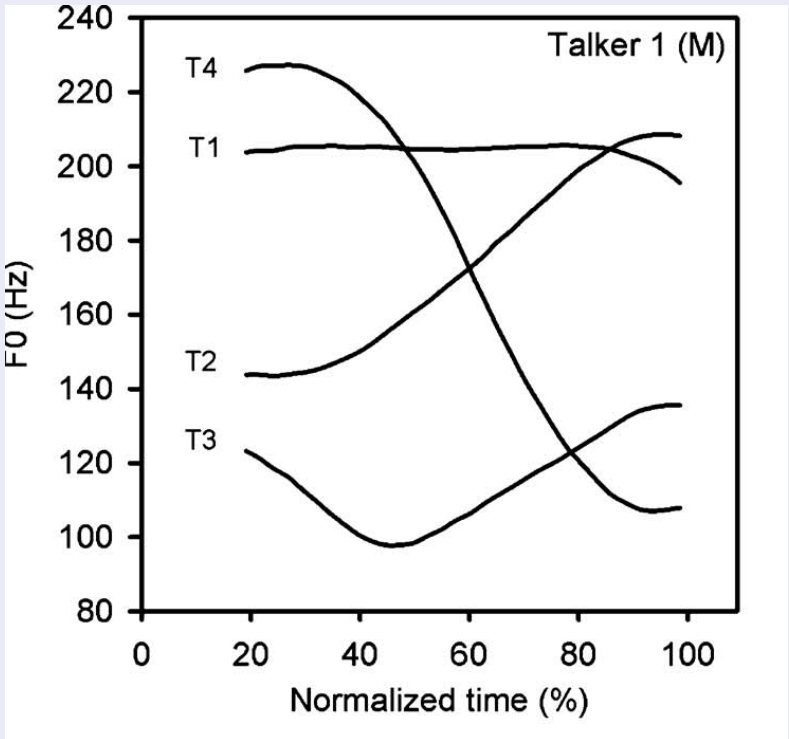
Pitch in Lexical Tone

- Pitch as a contrastive property of words
- Complex phonetic realizations mapped to abstract phonological categories
- Tone includes other acoustic correlates, but I'll focus only on F0.

Mandarin, Sino-Tibetan

(1) Wong and Perrachione (2007)

a. ma^{55} 'mother'
b. ma^{35} 'hemp'
c. ma^{214} 'horse'
d. ma^{51} 'scold'



Chandrasekaran et al. (2010)

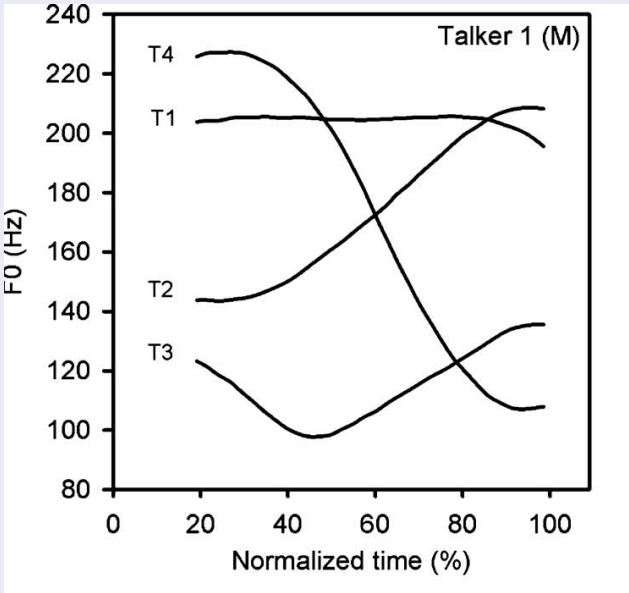
Pitch in Lexical Tone

Phonetic Cues

Multiple Dimensions of Pitch

The pitch of a given syllable can be perceived along multiple dimensions.[a]

- 'Static'
  - average F0 (*height*)
  - endpoint F0
- 'Dynamic'
  - F0 *direction*
  - F0 *slope*



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[a] Gandour and Harshman (1978)

Pitch in Lexical Tone

Phonetic Cues

Crosslinguistic Differences

Speakers of different languages rely on different cues when perceiving the tones of their own or another language.

- *height*
  - English $>$ Thai, Yoruba [a]
  - English, Cantonese $>$ Mandarin [b]
- *direction*
  - Thai, Yoruba $>$ English [a]
  - Mandarin, Cantonese $>$ English [b]
- *slope*
  - Thai $>$ Yoruba $>$ English [a]
  - Mandarin, Cantonese $>$ English [b]

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[a] Gandour and Harshman (1978)
[b] Gandour (1983)

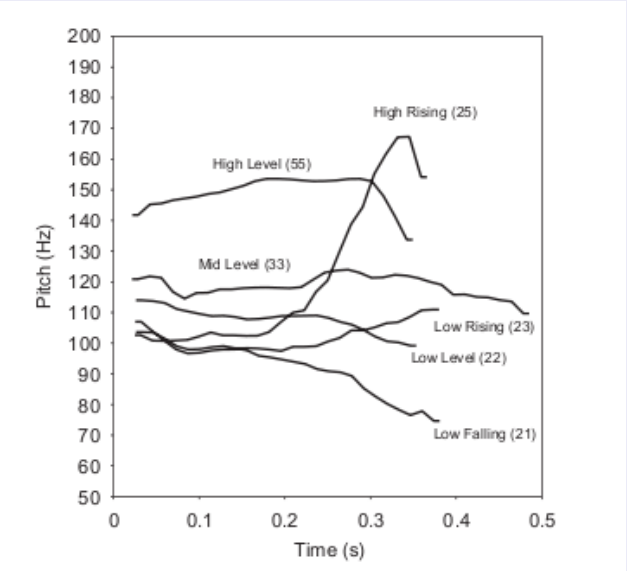
Pitch in Lexical Tone

Phonetic Cues

Crosslinguistic Differences

These are reflected in L2 error patterns...

- Cantonese confusion patterns[a]
  - Mandarin listeners confuse tones with similar *slope* and different *height*.
  - English listeners confuse tones with similar *height* and different *slope*.



[a] Francis et al. (2008)

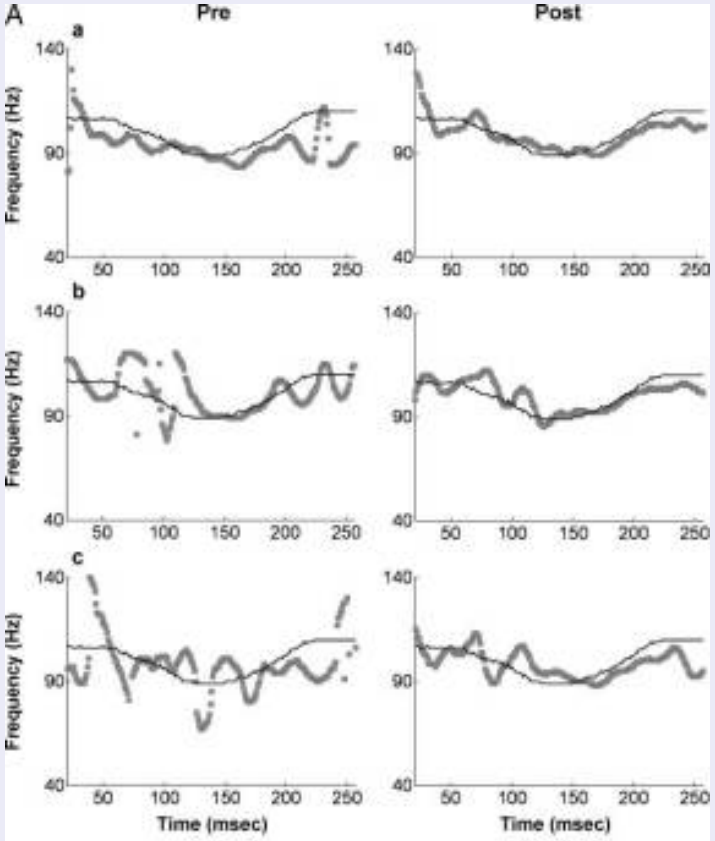
Pitch in Lexical Tone

Phonetic Cues

Crosslinguistic Differences

. . . and neural changes

- English speakers learning Mandarin tones show increased pitch tracking in the auditory brainstem.[a]



[a] Song et al. (2008)

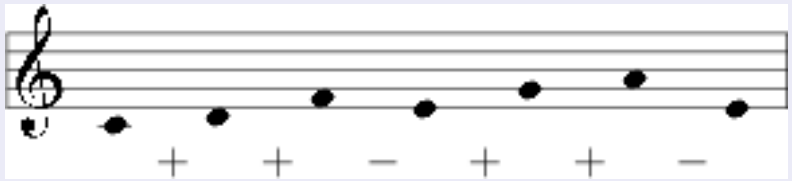
Pitch as Melody

What are the perceptual subcomponents of music?

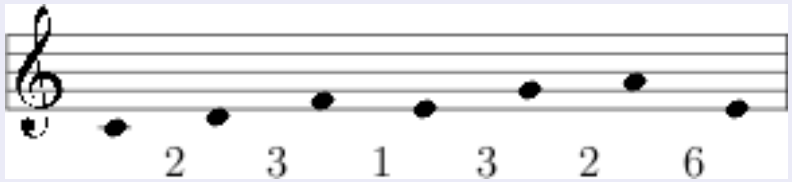
- These are dissociable, and tuned by musical training.[a]
- *contour* is more salient in most contexts, especially to nonmusicians.

[a] Massaro et al. (1980); Edworthy (1985); Peretz and Babaï (1992)

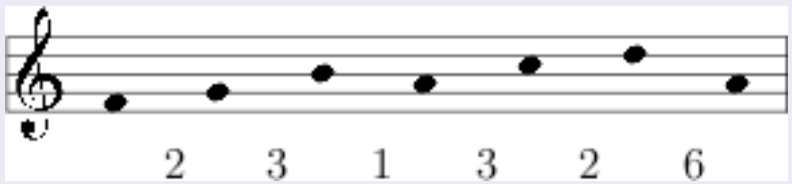
Contour



Interval



Key



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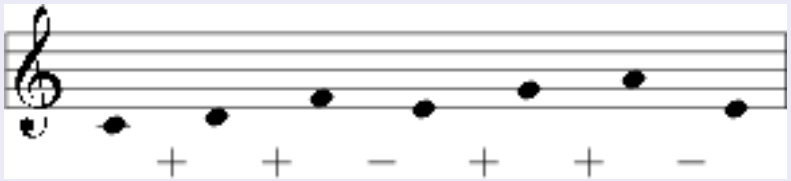
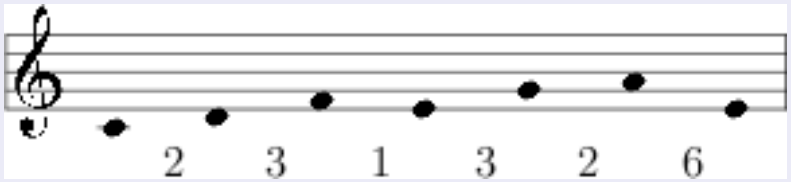


Interval



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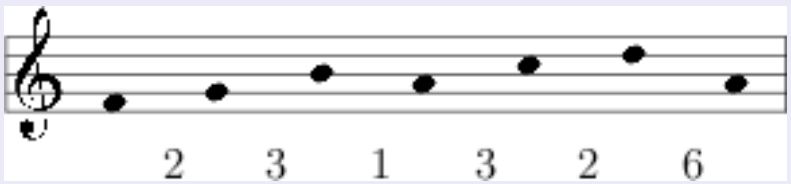

Outline

Questions & Hypotheses

Linking Perceptual Units

- I argue that these structural properties of melody and tone are linked by basic auditory mechanisms.
- Experience in one domain leads to tuning of resources that affect the other; thus,
  - Speakers of languages which rely heavily on *direction* to perceive tone will more accurately perceive melodic *contour* than those who don't.
  - Speakers of languages which rely heavily on *slope* to perceive tone will more accurately perceive melodic *interval* than those who don't.

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Outline

Subjects

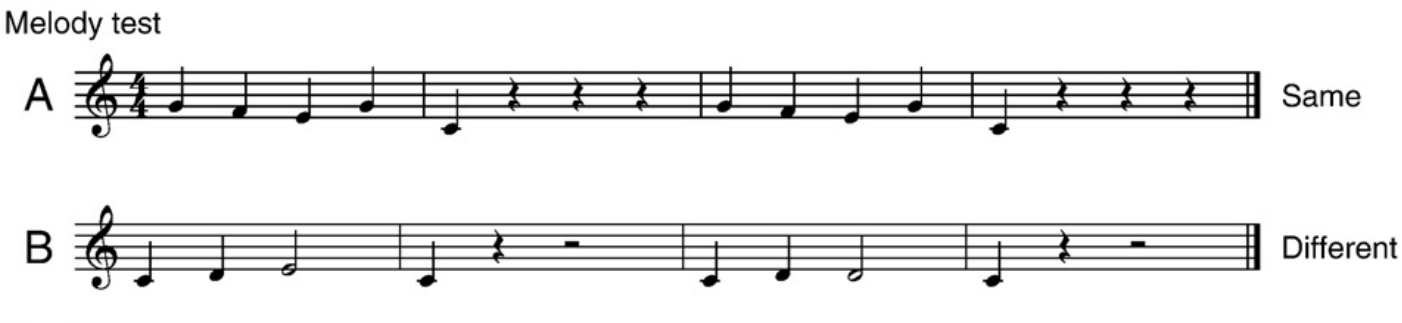
- English ($n = 21$)
  - nontone language
- Mandarin ($n = 20$)
  - contour tone language
  - *direction* and *slope* are important cues

- No tone language exposure beyond L1
- Nonmusicians (<5 years)

Musical Ear Test

Wallentin et al. (2010)

- Melodic discrimination subtest
- Includes a variety of melody types (length, major/minor, atonal)
- Includes *contour*-changing and *interval*-changing (*contour*-preserving) violations
- Modified to include transpositions (*key*-changing/*interval*-and-*contour*–preserving violations)
- 13 trials of each violation, 78 total trials



Results

Signal detection analysis

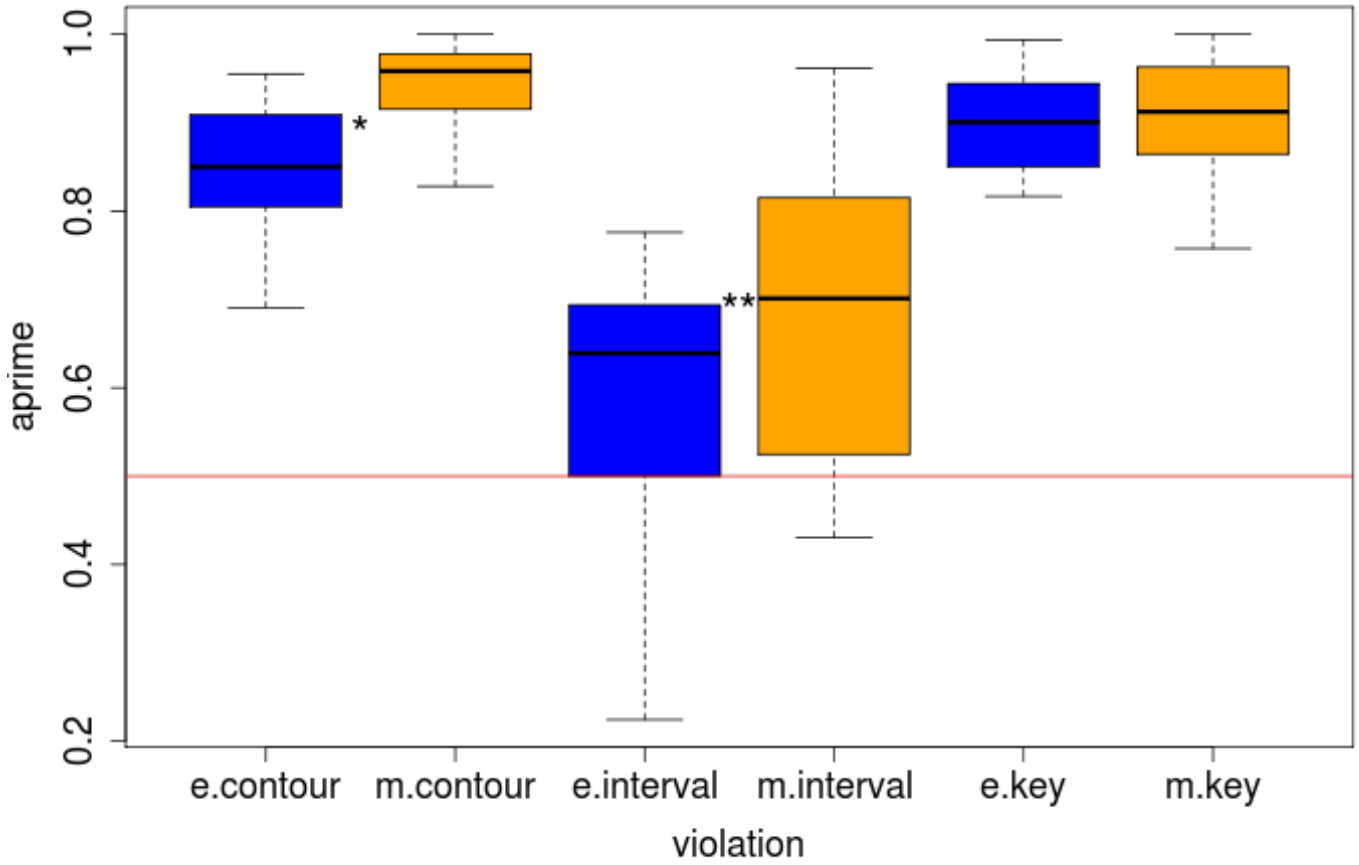
- Discriminability (a') computed for each violation type per subject
- Entered into a *language*$\times$*violation* repeated-measures ANOVA

	x	o
x	hit	miss
o	fa	

$$a' = 1/2 + \frac{(hit - fa) * (1 + hit - fa)}{4 * hit * (1 - fa)} \quad (1)$$

Results

Discriminability of Violations



- L1 ($F(1, 38) = 9.058, p = .005$), violation ($F(2, 76) = 116.606, p < .001$)
- L1 $\times$ violation ($F(2, 76) = 2.939, p = .058$); post-hoc * $p_{adj} = .05$, ** $p_{adj} = .01$

Results

Summary

- Effects of native language tonality on melody were specific, rather than general.

key	Mandarin = English
contour	Mandarin $>$ English
interval	Mandarin $>>$ English

- Why a smaller difference on *contour*?
  - *contour* was 'too easy' for English speakers (ceiling effect)?
  - *slope* is more important to Mandarin speakers than *contour*?

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Experiment 2a

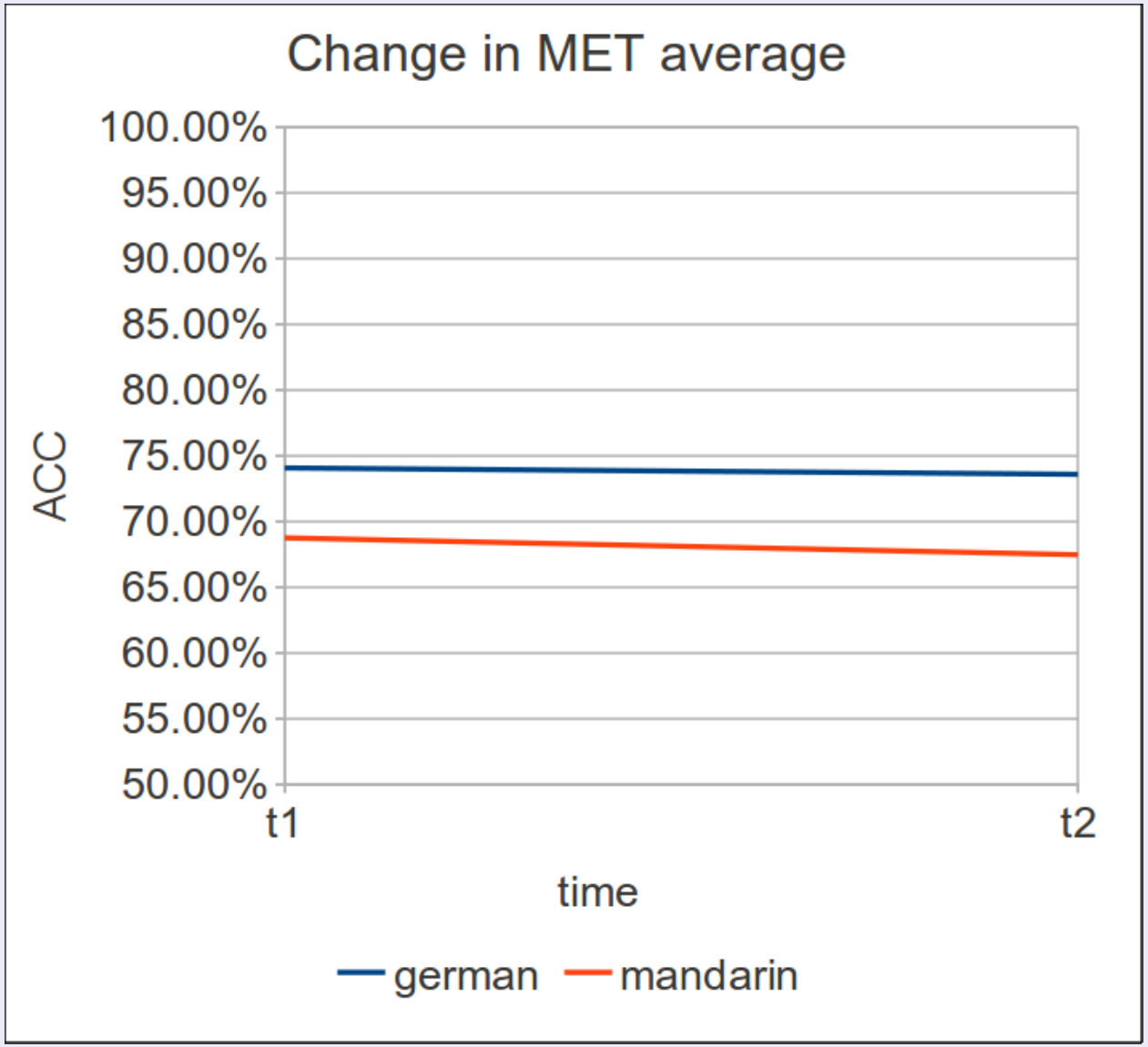
How does L2 compare to L1?

- English-speaking learners of Mandarin ($n = 17$)
- English-speaking learners of German ($n = 11$)

- No other tone language exposure
- Nonmusicians ($<$5 years)
- completed MET at beginning and end of semester

Experiment 2a

Results



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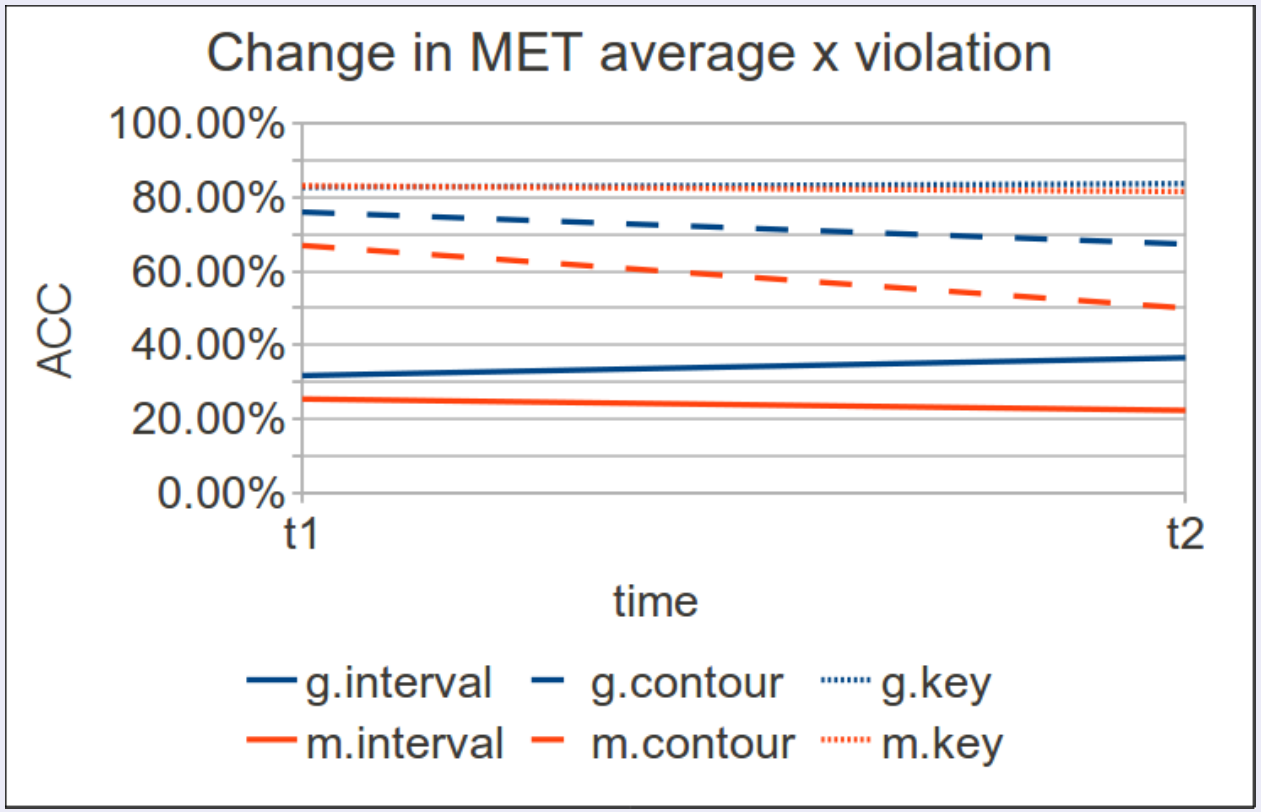

Experiment 2b

- English-speaking learners of Mandarin at 3 levels
  - 105 (beginner) ($n = 7$)
  - 107 (intermediate) ($n = 6$)
  - 201 (advanced intermediate) ($n = 8$)
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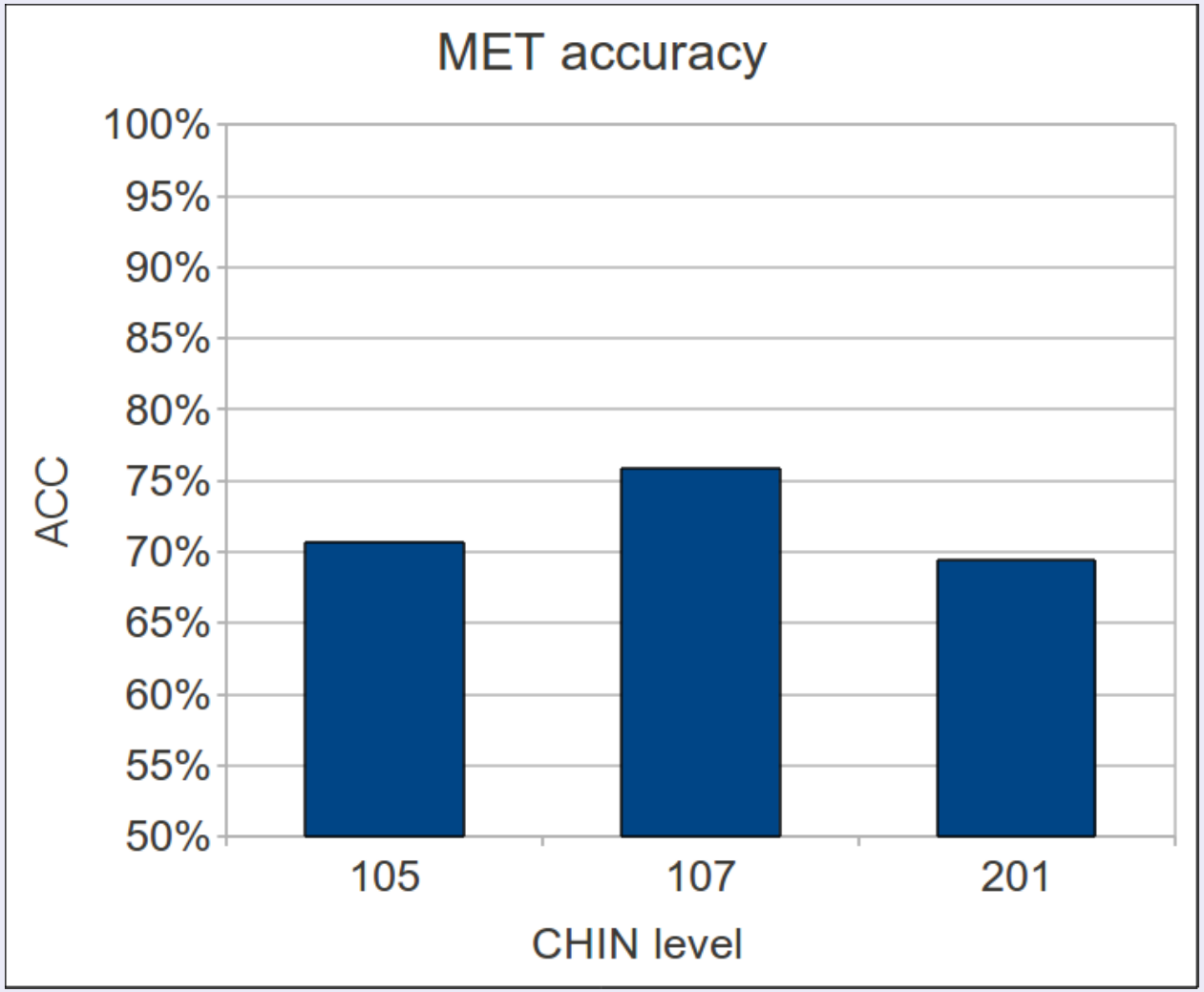
- Completed MET at beginning of semester

Experiment 2b

Results



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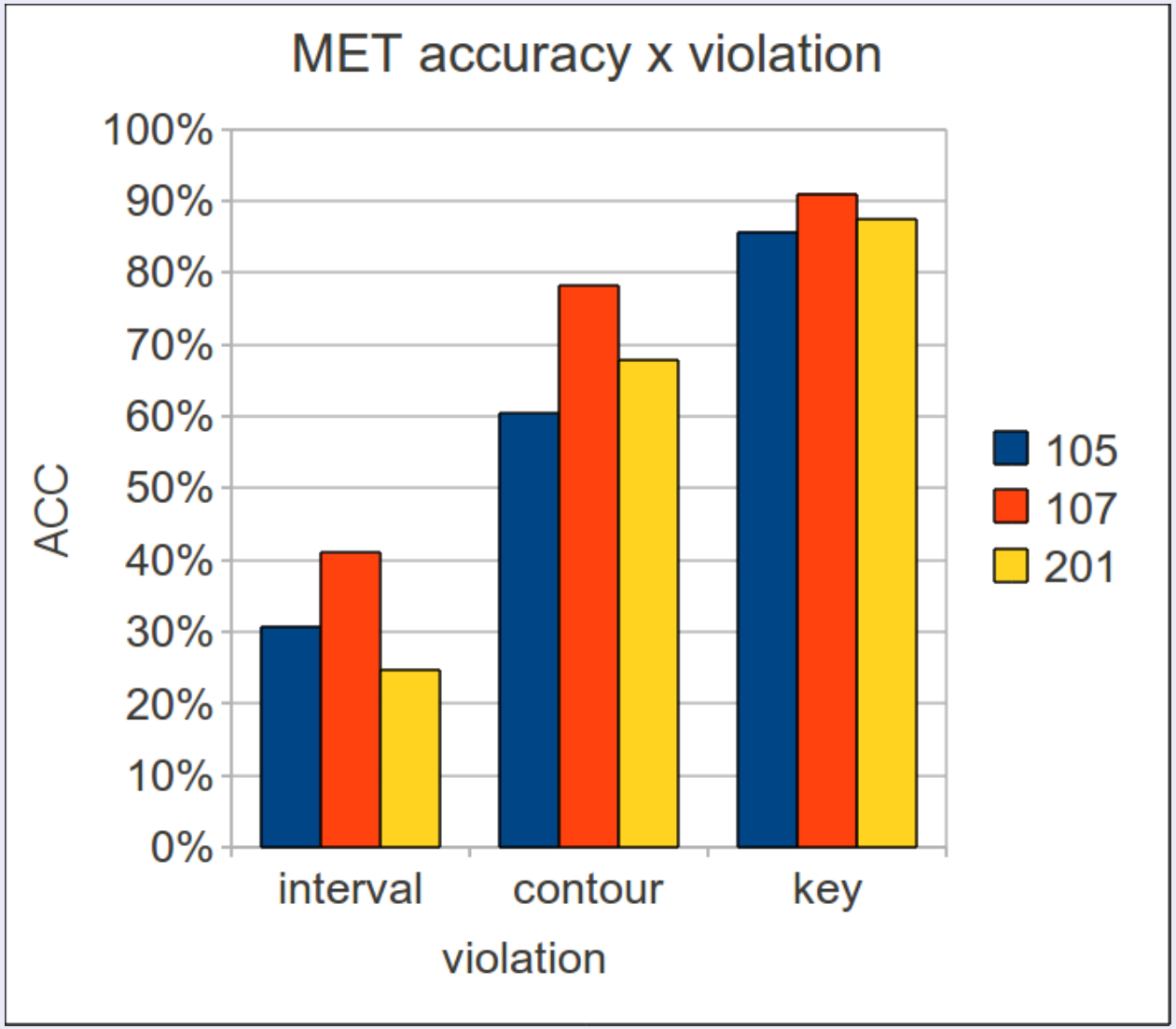
Results



Summary

- Melody discrimination findings support the assertion that at least some cases of language–music crossover are driven basic auditory properties relevant to both domains.
- This suggests that language and music, at this level, share the same neural resources.
- The proposed mapping between the relevant properties of music and language is partially supported.
- This leads to predictions about other languages, and further work will refine the correspondence.
- These generalizations have not yet been extended to second language experience.
- Data from more advanced learners are needed to fully track cross-domain effects of tone learning in adulthood.

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