Individual differences in talker identification: Do musical experience and linguistic background matter?

Xin Xie[1] and Emily Myers[1,2]

[1]*Department of Psychology;* [2] *Department of Speech, Language, and Hearing Sciences*
University of Connecticut

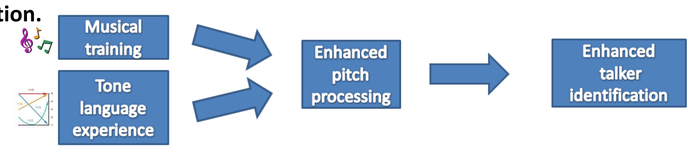
Language and Brain Lab

INTRODUCTION

PITCH IN TALKER IDENTIFICATION

- Pitch (f0) is an important dimension in talker identification.
- Individuals also vary widely in their ability to identify talkers.
- **Musical training sharpens pitch acuity.**
  - Musicians outperform non-musicians in *non-linguistic* pitch processing [1] and *linguistic* use of pitch, such as in lexical tones [2] and sentence prosody [3].
- **Tonal language experience improves pitch-related processing.**
  - Native tonal language users have advantages in a variety of tasks involving lexical tones (*linguistic*)[4] and in production/perception of musical pitch (*nonlinguistic*)[5].

OVERARCHING HYPOTHESIS: Pitch processing abilities are related to talker identification.



Q1. Do musicianship and tone language experience enhance talker identification by sharpening pitch perception skills in a domain-general manner?
Q2. Will experience-dependent advantages in talker identification exhibit different patterns in the native language vs. unfamiliar languages?

- **Language Familiarity Effect:** Talker identification is easier in one's native language than in unfamiliar languages [6].

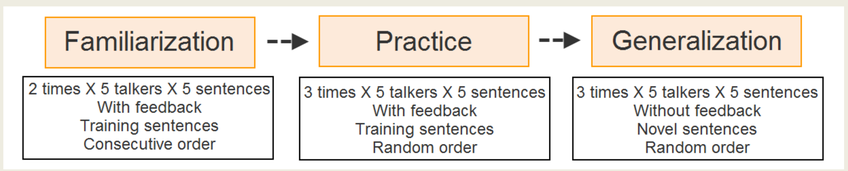
METHODS

EXPERIMENT 1

TASKS

TALKER IDENTIFICATION TASK:

- Blocked by language condition: Mandarin, Spanish, or English; counterbalanced (5 native male speakers in each language condition)



PARTICIPANTS

26 native-English non-musicians
10 native-English musicians
25 native-Mandarin non-musicians

EXPERIMENT 2

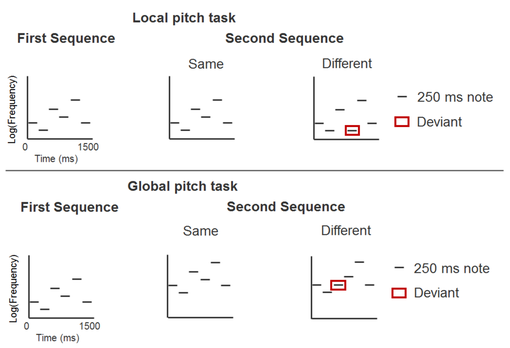
TASKS

TALKER IDENTIFICATION TASK (see Exp 1):

- Blocked by Language Condition (Mandarin or English)

PITCH PERCEPTION TASK

- 40 pairs of pure tone sequences (20 same, 20 different)
- Each sequence contained six pure tones
- **Local pitch task:** changes in *height*
- **Global pitch task:** changes in *contour*



PARTICIPANTS

Definition:
ME: musicians with extensive training (>=6 yrs);
MM: musicians with minimal training (<= 1 yr);
NM: non-musicians

	native-English		native-Mandarin	
	N	Years of training	N	Years of training
ME	20	9.20 (2.86)	14	8.14 (1.91)
MM	23	3.08 (1.56)	14	2.68 (1.61)
NM	32		31	

RESULTS

EXPERIMENT 1

Do musicianship and tone language experience enhance talker identification? (Fig. 1)

- **YES!**
  - [English M & Mandarin NM] > English NM p <.01
  - English M = Mandarin NM p = .20
- **Replicate language familiarity effect** p < .001
  - English: English M = English NM > Mandarin NM p < .001
  - Mandarin: Mandarin NM > English M p < .001
- **English musicians outperform non-musicians in non-native languages**
  - English M > English NM p < .01
  - Spanish: English M > English NM p < .005

EXPERIMENT 2

Do pitch processing abilities relate to talker identification skills?

Figure 2: Talker identification

- **Musicianship predicts better talker ID** p < .005
  - ME > NM p = .005; MM > NM p = .06; MM = ME *n.s.*
- **Tone language experience enhances talker ID**
  - Mandarin listeners > English listeners p < .05
- **Language familiarity effect** p < .001.

Figure.3: Pitch perception

- **Musical training enhances pitch skills** p < .001
  - ME > NM p < .001; MM > NM *n.s*; MM = ME *n.s.*
- **Tone language experience enhances pitch skills**
  - Mandarin listeners > English listeners p < .001
- Interaction: task differences larger in the English listeners overall p < .001

Figure.4: Mediation analysis

Non-native language condition

- **Musical training predicted pitch perception.**
- Indirect effect of musical training on talker ID, mediated by pitch perception p < .05.
- **Tone language experience predicted pitch perception.**
- Indirect effect of tone language experience on talker ID p < .05.

Native language condition

- No effect of musical training (p = .18) or tone language experience (p = .47) on talker ID

DISCUSSION

Talker Identification: The Role of Pitch Experience

Musical training:

- Musicianship predicted pitch processing sensitivity.
- Musicians had a benefit over non-musicians when identifying talkers in *unfamiliar* languages.

Tone language experience:

- Tone language speakers (Mandarin listeners) had enhanced pitch perception compared to non-tone language speakers (English listeners).
- Mandarin listeners outperformed English listeners in talker identification in *unfamiliar* languages.

→ **Taken together, these results suggest an interaction between language skills and pitch processing ability in talker identification.**

Shared Mechanisms: Music, Language and Voice Perception

- Previously, bi-directional influences between musical and linguistic pitch use [7].
- **Domain-specific training (musical training/lexical tone use) heightens listeners' sensitivity to pitch, and transfers to voice identity perception.**

Fig.1 Talker identification as a function of musical/tone language experience

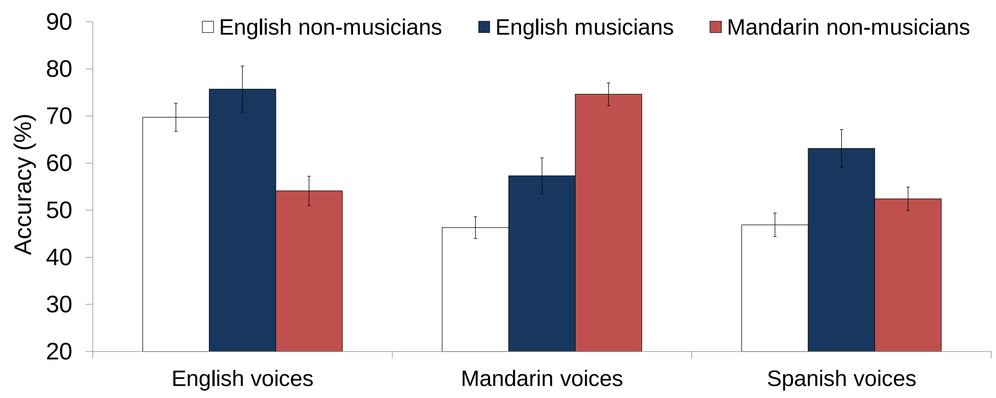


Fig.2 Talker identification accuracy as a function of listener group for (A) English voices and (B) Mandarin voices

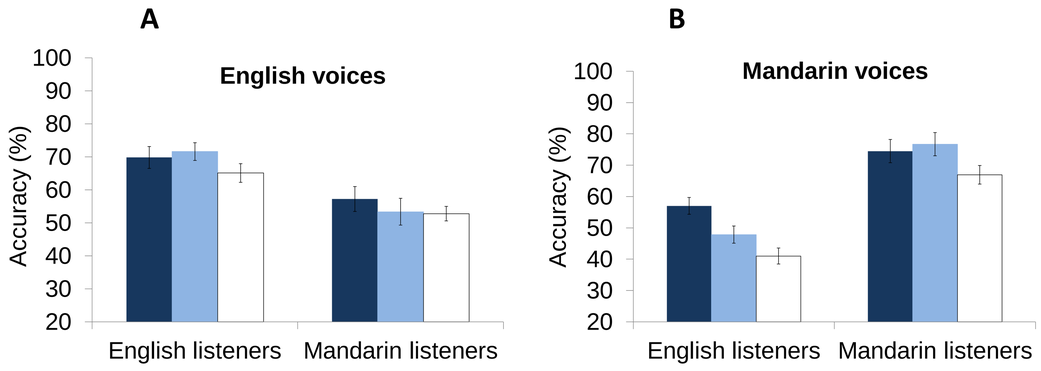


Fig.3 Pitch perception sensitivity as a function of listener group for (A) local pitch task and (B) global pitch task

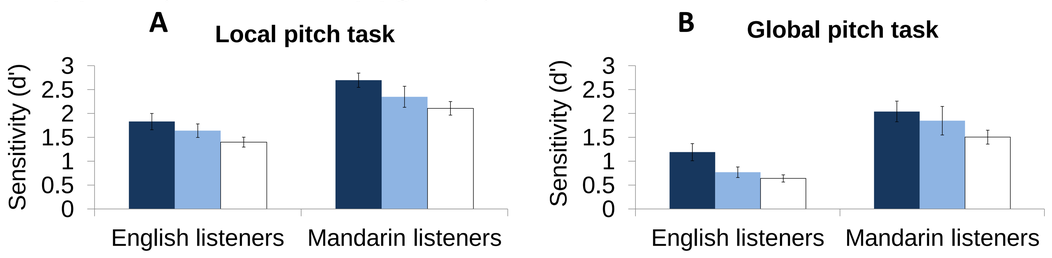
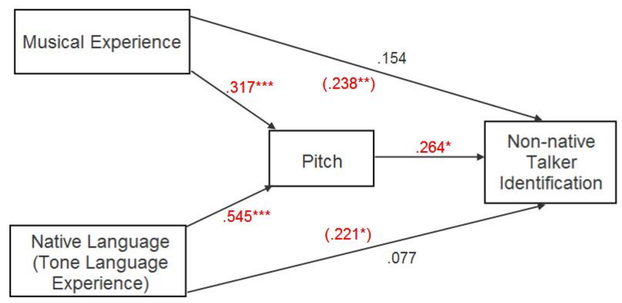


Fig.4 The *mediating* effect of pitch perception on talker identification

***Predictors*:**
Musical experience (length of musical training in years)
Tone language experience (English = 0; Mandarin = 1)
***Mediator*:**
Pitch perception sensitivity (average log-transformed d') across the two pitch tasks)
Dependent variable:
Talker identification accuracy (non-native and native)



*p < .05; ** p < .01; *** p <. 001. Numbers in parentheses indicate the total effect of listener experience on talker identification, without controlling for pitch. The total effect of musicianship /tone language experience on talker ID in the native conditions did not reach significance (*p*s > .10).

WORKS CITED:

1.Bidelman G. M., Hutka S., & Moreno, S. (2013). Tone language speakers and musicians share enhanced perceptual and cognitive abilities for musical pitch: evidence for bidirectionality between the domains of language and music. *PLoS ONE 8*:e60676.
2. Burnham, D., Brooker, R., & Reid, A. (In press, 2014) The effects of absolute pitch ability and musical training on lexical tone perception. *Psychology of Music.*
3. Marques C, Moreno S, Castro SL, Besson M. 2007. Musicians detect pitch violation in a foreign language better than non-musicians: behavioural and electrophysiological evidence. *J Cogn Neurosci. 19,* 1453--1463.
4. Krishnan, A., Swaminathan, J., & Gandour, J. T. (2009). Experience-dependent enhancement of linguistic pitch representation in the brainstem Is not specific to a speech Context. *Journal of Cognitive Neuroscience, 21*(6), 1092-1105.
5. Pfordresher, P. Q., Brown, S., (2009). Enhanced production and perception of musical pitch in tone language speakers. *Attention, Perception & Psychophysics, 71,* 1385-1398.
6. Perrachione, T. K., Pierrehumbert, J. B., & Wong, P. M. (2009). Differential neural contributions to native- and foreign-language talker identification. *Journal of Experimental Psychology: Human Perception And Performance, 35(6),* 1950-1960.
7. Patel A. D. (2011). Why would musical training benefit the neural encoding of speech? The OPERA hypothesis. *Front. Psychol.*2:142.10.3389/fpsyg.2011.00142.

ACKNOWLEDGEMENTS: This work was supported by NIH NIDCD R03 DC009495 (Myers, PI).