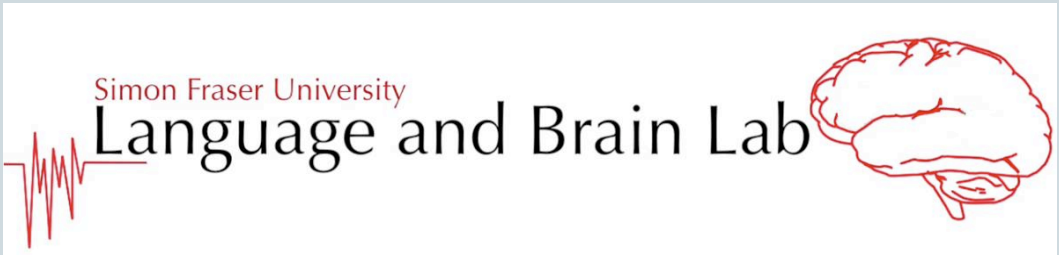
Effects of Linguistic experiences on the perception of lexical tones, non-speech tones, and musical tones

DANIEL CHANG

FOR LING 851+ COGS 300 + END OF SEMESTER PRESENTATION

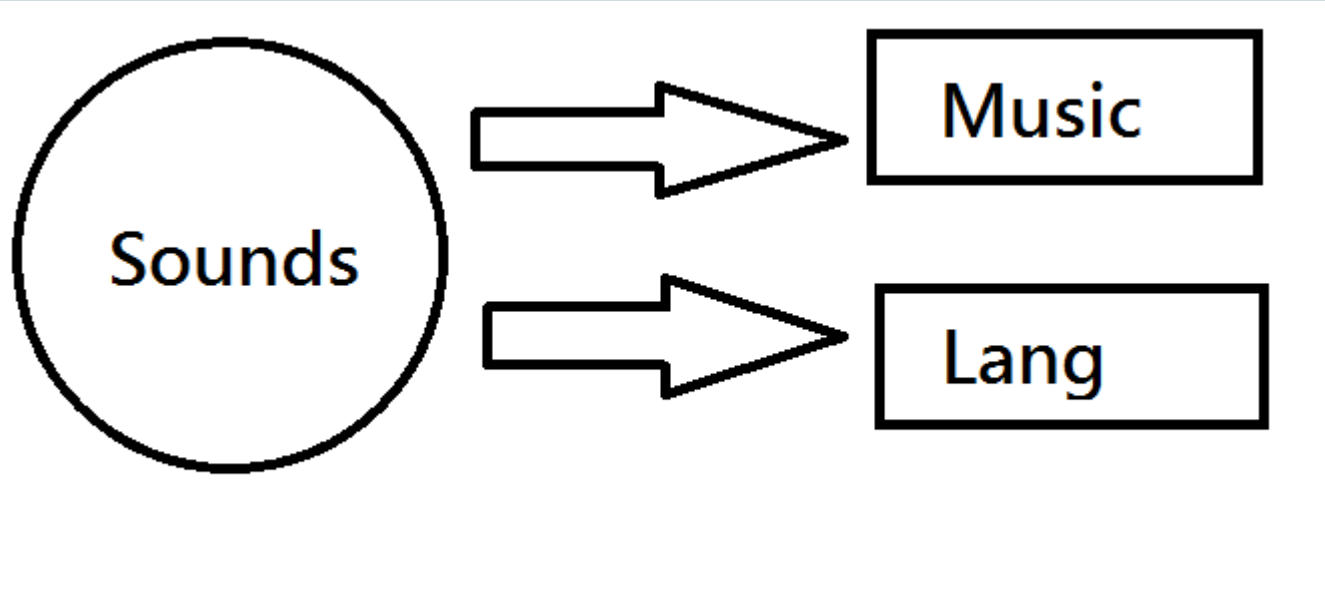


Music and Language Interaction

- **SSCLMH** *Shared Sound Category Learning Mechanism Hypothesis* (Patel, 2008)

⇒Domain General versus Domain specific process

⇒Development versus end product



Processing types

- **Domain General Processing** (Zatorre and Gandour, 2007)

⇒Bottom-up processing

⇒Sensitive to pitch differences

(E.g. know the differences between two sounds)

- **Domain specific Processing** (Zatorre and Gandour, 2007)

⇒Top-down processing

⇒Sensitive to pitch category

(E.g. know what sounds are being produced)

Similarities between Music and Language

- The similarities between music and language (Bradley, 2012)

Music	Language
Key	Height
Contour	Direction
Interval	Slope

- Non-tone language speakers are more aware of height differences, as height is the basic acoustic cues for all the languages (Gandour and Harshman, 1987).
- Tone speakers are more aware of the combinations of the three: how pitch is moved (Gandour and Harshman, 1987).

Effects of language on pitch processing

- **Experience Dependent Plasticity**

⇒A transfer effect from one domain to the other domain (Bidelman, Gandour, & Krishnan, 2011a; Chandrasekaran, Krishnan, & Gandour, 2007)

- **Enhanced Perception of tones**

⇒Tone-non-musicians: discriminating/imitating pitch intervals (Alexander et al., 2010; Pfordresher and Brown, 2009)

⇒Musicians: identifying music notes (Duetch et al., 2009)

- **Weakened Perception of tones**

⇒Tone-non-musicians: not good at identifying melodic sequence (Alexander et al., 2010); not good at identifying non-speech tones (Bent et al., 2006)

Experience Dependent Plasticity

The influence of language experience on linguistic-relevant pitch contour

⇒ The processing of contour pitch depends on acoustic similarities (Chandrasekaran, Krishnan, & Gandour, 2007)

⇒ Transfer effect from language to language (Krishnan, Gandour, and Bidelman, 2009)

The influence of language experience on musical pitch perception

⇒ Transfer effect from language to music neurologically but not behaviorally (Bidelman, Gandour, Krishnan, 2011)

⇒ Why not behaviorally?

(1) Musical training differences

(2) Relevancy of information

Enhanced Perception of Tones

- For non-musicians, speaking a tone language positively influences the discrimination/imitation of melodic tones (Pfordresher and Brown, 2009)
- **Note:** it's different when the tone language speakers are musically trained.

- In general, for tone-speaking non-musicians, they have…

⇒Established lexical tone categories

⇒Enhanced sensitivity to pitch differences through **perceptual attunement mechanism** (Gibson, 1963 cited in Pfordresher and Brown, 2009)

⇒Had ability to imitate/repeat melodic tones.

Enhanced Perception of Tones

- For musicians with a tone language background, speaking a tone language gives them additional advantage for identifying music tones.

⇒Absolute pitch memory for music (Deutsch, Henthorn, and Head, 2009)

⇒Absolute pitch for the language (Deutsch et al., 2004)

⇒Critical Period in language and music (?)

Weakened Perception of tones

- Speaking a tone language negatively affects the identification of melodic/non-speech tones for non-musicians.

⇒**Tone-category interference** (Alexander et al., 2010)

⇒**Acoustic threshold and Listening Strategy used** for identifying non-speech tones and speech tones (Bent et al., 2006)

⇒**Cognitive Demand/Information Relevancy** for and discriminating non-speech tones and non-native lexical tones (Qin and Mok, 2006)

Summary of Past Studies

Previous Study Results

	Discrimination	Identification
Lexical Tones	Tone > Control (Stevens et al., 2004)	Tone > Control (Bent et al., 2006)
Non-speech tones	Tone = Control (Bent et al., 2006) Tone > Control (Peng et al., 2010) Tone > Control (Giuliano et al., 2011)	Tone < Control (Bent et al., 2006) Tone = Control (Peng et al., 2010)
Melodic Tones	Tone > Control (Alexander et al., 2011; Pfordresher and Brown, 2009)	Tone < Control (Alexander et al., 2011)

The Present Study

- **The Aim**

⇒ to investigate the linguistic influences on the processing of pitch tones at different levels (lexical tone, non-speech tones, and melodic tones)

- **Rationale:**

⇒ According to SSCLMH, lexical tone category in tone-speakers may influence the perception of non-speech and music sounds.

⇒ Based on Bent et al. (2006)'s study that tone speakers may employ different listening strategies for perceiving non-speech tones, one may expect this can be extended to the context of music as well.

- **Who?**

⇒ Mandarin speakers and English speakers

- **How?**

⇒ Task: Discrimination and Identification Task

The Present Study - Hypotheses

- **General Hypothesis**: Acquisition of a tone language influences tone perceptions.

- **Directional Hypotheses:**

⇒**Higher-level Processing:** speaking a tone language negatively affects the identification of melodic tones as well as non-speech tones.

⇒**Lower-level Processing:** speaking a tone language positively reinforces the discrimination of the melodic tones and non-speech tones.

Methodology

- **Independent Variables**

⇒Language Background (Tone, Non-tone Group)

⇒Type of Stimuli (Mandarin Tones, Non-speech Tones, and Melodic Tones)

- **Dependent Variables:**

⇒Accuracy Scores obtained from discrimination task and identification task

Stimuli

- **Mandarin Tones**

⇒Produced by a male Mandarin speakers and a female Mandarin speakers

- **Non-speech Tones**

⇒Extract the pitch contour from the speakers; synthesize it with a sine-wave sound by Praat

- **Melodic Tones**

⇒Computer-generated Piano Tones

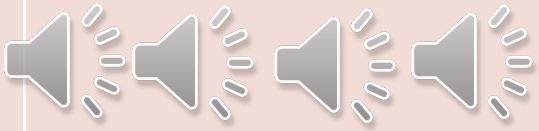
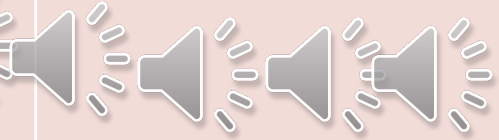
Stimuli

- Following the method of Pisoni (1978), who found that when ISI is set 250 ms, the discrimination score achieved the maximum value.
- Duration is set at 300 ms is that it is the ideal duration for short-term storage memory for identification tasks (Cowan, 1984; Xu et al., 2006).

Sample Stimuli for Identification

Mandarin Tones	Non-speech Tones	Melodic Tones

Sample Pairs of Stimuli for Discrimination

Tone pairs	Mandarin Tones / Jia/	Non-speech Tones	Melodic Tones
(11,12,13,14)			
(21,22,23,24)			
(31,32,33,34)			
(41,42,43,44)			

Data Analysis

- **2-Way ANOVA Analysis**

⇒Main Effects of Language Background (Tone, Non-tone)

⇒Independent variables (Tone types)

- **Post Hoc Analysis on tone types**

⇒(Mandarin Tones, Non-speech Tones, and Melodic Tones)

Expected Results

Task	Discrimination		Identification	
Tone Type\Lang	**Mandarin**	**English**	**Mandarin**	**English**
Mandarin Tones	☺		☺	
Non-speech	☺			☺
Music	☺			☺

Questions?

Remaining Issues

1) Experiment Set-up and Presentation
2) Contribution of my study

References

- Alexander, J. A., Bradlow, A. R., Ashley, R. D. & Wong, P. (2011). Music-melody perception in tone-language and non-tone-language speakers. *Psycholinguistic representation of tone. Hong Kong. http://www. sfu. ca/\~ jaa37/index files/Alexander et al.*
- Bent, T., Bradlow, A. R. & Wright, B. A. (2006). The influence of linguistic experience on the cognitive processing of pitch in speech and nonspeech sounds. *Journal of Experimental Psychology: Human Perception and Performance*, *32*(1), 97.
- Bialystok, E. (2011). Reshaping the mind: The benefits of bilingualism. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale*, *65*(4), 229.
- Bialystok, E., Craik, F. I. M., Green, D. W. & Gollan, T. H. (2009). Bilingual minds. *Psychological Science in the Public Interest*, *10*(3), 89–129.
- Bialystok, E. & DePape, A. M. (2009). Musical expertise, bilingualism, and executive functioning. *Journal of Experimental Psychology: Human Perception and Performance*, *35* (2), 565.
- Bidelman, G. M., Gandour, J. T. & Krishnan, A. (2011). Musicians demonstrate experience-dependent brainstem enhancement of musical scale features within continuously gliding pitch. *Neuroscience letters*, *503*(3), 203–207.
- Chandrasekaran, B., Krishnan, A. & Gandour, J. T. (2007). Mismatch negativity to pitch contours is influenced by language experience. *Brain research*, *1128*(1), 148–156.
- Cooper, A. K. (2010). *Effects of linguistic and musical experience on Cantonese tone word learning*.
- Cooper, A. & Wang, Y. (2012). The influence of linguistic and musical experience on Cantonese word learning. *The Journal of the Acoustical Society of America*, *131*, 4756.
- Deutsch, D., Dooley, K., Henthorn, T. & Head, B. (2009). Absolute pitch among students in an American music conservatory: Association with tone language fluency. *The Journal of the Acoustical Society of America*, *125*, 2398.
- Deutsch, D., Henthorn, T. & Dolson, M. (2004). Absolute pitch, speech, and tone language: Some experiments and a proposed framework. *Music perception*, *21*(3), 339–356.
- Deutsch, D., Henthorn, T., Marvin, E. & Xu, H. S. (2006). Absolute pitch among American and Chinese conservatory students: Prevalence differences, and evidence for a speech-related critical period. *The Journal of the Acoustical Society of America*, *119*, 719.

References

- Ettlinger, M., Margulis, E. H. & Wong, P. C. M. (2011). Implicit memory in music and language. *Frontiers in Psychology*, *2*.
- Gandour, J. (1983). Tone perception in Far Eastern languages. *Journal of Phonetics*, *11*(2), 149–175.
- Gandour, J., Wong, D. & Hutchins, G. (1998). Pitch processing in the human brain is influenced by language experience. *Neuroreport*, *9*(9), 2115–2119.
- Giuliano, R. J., Pfordresher, P. Q., Stanley, E. M., Narayana, S. & Wicha, N. Y. Y. (2011). Native experience with a tone language enhances pitch discrimination and the timing of neural responses to pitch change. *Frontiers in Psychology*, *2*.
- Hove, M. J., Sutherland, M. E. & Krumhansl, C. L. (2010). Ethnicity effects in relative pitch. *Psychonomic bulletin \& review*, *17*(3), 310–316.
- Klein, D., Zatorre, R. J., Milner, B., Zhao, V. & others. (2001). A cross-linguistic PET study of tone perception in Mandarin Chinese and English speakers. *Neuroimage*, *13*(4), 646–653.
- Koelsch, S., Schröger, E. & Tervaniemi, M. (1999). Superior pre-attentive auditory processing in musicians. *NeuroReport*, *10*(6), 1309–1313.
- Krishnan, A., Gandour, J. T. & Bidelman, G. M. (2010). The effects of tone language experience on pitch processing in the brainstem. *Journal of neurolinguistics*, *23*(1), 81–95.
- Krizman, J., Marian, V., Shook, A., Skoe, E. & Kraus, N. (2011). Classification: 1. Biological Sciences: Neuroscience 2. Social Sciences: Psychological and Cognitive Sciences Title: Bilingualism and the brain: Subcortical indices of enhanced executive function.
- Lee, C. Y. & Hung, T. H. (2008). Identification of Mandarin tones by English-speaking musicians and nonmusicians. *The Journal of the Acoustical Society of America*, *124*, 3235.
- Magne, C., Schön, D. & Besson, M. (2006). Musician children detect pitch violations in both music and language better than nonmusician children: behavioral and electrophysiological approaches. *Journal of Cognitive Neuroscience*, *18*(2), 199–211.
- Marie, C., Delogu, F., Lampis, G., Belardinelli, M. O. & Besson, M. (2011). Influence of musical expertise on segmental and tonal processing in Mandarin Chinese. *Journal of cognitive neuroscience*, *23*(10), 2701–2715.

References

- Mattock, K. & Burnham, D. (2006). Chinese and English infants' tone perception: Evidence for perceptual reorganization. *Infancy*, *10*(3), 241–265.
- Moreno, S., Bialystok, E., Barac, R., Schellenberg, E. G., Cepeda, N. J. & Chau, T. (2011). Short-term music training enhances verbal intelligence and executive function. *Psychological science*, *22*(11), 1425–1433.
- Patel, A. D. (2010). *Music, language, and the brain*. Oxford University Press, USA.
- Patel, A. D. & Iversen, J. R. (2007). The linguistic benefits of musical abilities. *Trends in cognitive sciences*, *11*(9), 369–372.
- Peretz, I., Nguyen, S. & Cummings, S. (2011). Tone language fluency impairs pitch discrimination. *Frontiers in psychology*, *2*.
- Pfordresher, P. Q. & Brown, S. (2009). Enhanced production and perception of musical pitch in tone language speakers. *Attention, Perception, \& Psychophysics*, *71*(6), 1385–1398.
- Schellenberg, E. G. (2004). Music lessons enhance IQ. *Psychological Science*, *15*(8), 511–514.
- Schellenberg, E. G. & Trehub, S. E. (2008). Is there an Asian advantage for pitch memory? *Music Perception*, *25*(3), 241–252.
- Schön, D., Magne, C. & Besson, M. (2004). The music of speech: Music training facilitates pitch processing in both music and language. *Psychophysiology*, *41* (3), 341–349.
- Stevens, C., Keller, P. & Tyler, M. (2004). Language tonality and its effects on the perception of contour in short spoken and musical items. *Proceedings of the 8th lnternational Conference on Music Perception \& Cognition. Adelaide, Australia*.
- Wong, P. C. M., Ciocca, V., Chan, A. H. D., Ha, L. Y. Y., Tan, L. H. & Peretz, I. (2012). Effects of Culture on Musical Pitch Perception. *PloS one*, *7*(4), e33424.

Enhanced Perception of tones

- Pfordresher & Brown (2009)

⇒**Research Question:** examine whether acquisition of tone language facilitates pitch processing in music

⇒**Participants:**

12 tone language speakers (mixed in language spoken)

40 English speakers

⇒**Task and Stimuli:**

Production Task (imitation)

Perceptual Task (discrimination)

Enhanced Perception of tones

⇒**Findings**

- Tone speakers outperform non-tone speakers in imitation task and discrimination task in general.
- Slightly unreliable advantage in imitating single pitches and discriminating single pitches.

⇒**Conclusion**

- Pitch processing is shared across domains.
- Consistent with Patel (2008)'s SSCLMH, that the brain resources are shared to process different representations.

Enhanced Perception of tones

- Deutsch, Henthorn, and Head (2009)

⇒**Research:** explore whether fluency in speaking a tone language affects absolute pitch performance in musicians.

⇒**Participants:**

176 English-speaking musicians

15 fluent tone language musicians

7 fairly-fluent tone language musicians

5 non-fluent tone language musicians

⇒**Task and Stimuli**

Music Note Identification Task

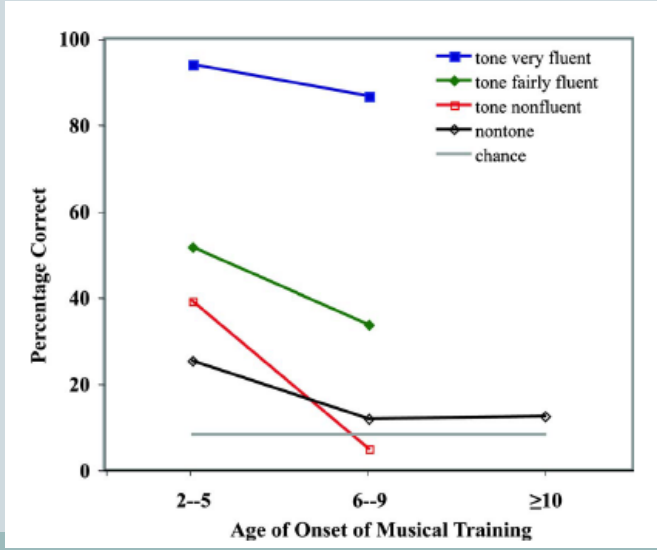
Enhanced Perception of tones

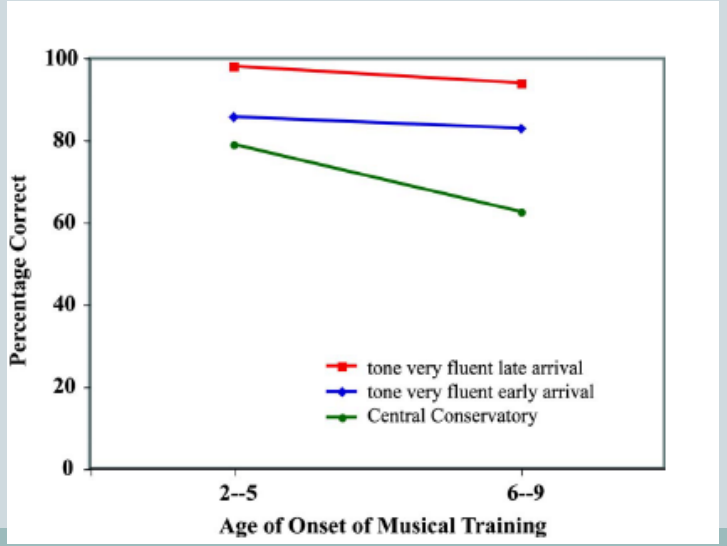
- Enhanced Perception of tones

⇒Maybe tone language speakers have absolute pitch, if they are musically trained?

⇒**Findings**

1) AP is prevalent in tone-fluently-speaking group if the musical training began at 2-5 age.





Weakened Perception of tones

- Alexander et al. (2010)

⇒**Research Question:** Examine the discrimination and identification of pitch in music by native English speakers and native Mandarin speakers.

=> **Participants**

14 Mandarin

14 English

⇒**Task and Stimuli**

Five-note sequence discrimination

Five-note sequence identification

Weakened Perception of tones

⇒**Findings**

	Discrimination	Identification
English		V
Mandarin	V	

⇒**Implications**

- Learned linguistic category interferes with novel musical pitch identification.