

# 2pSC. The Influence of Context Frequency on Lexical Tone Perception

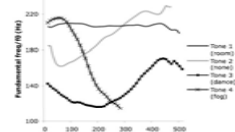
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## 1 Background

Tone languages use pitch to contrast meanings.  
“Speaker normalization” in lexical tones



Large overlap across tone categories (e.g. Xu, 1994)  
Tone categories are tuned dynamically to context information, at least for level tones (e.g. Francis et. al, 2006)  
Influence of context is less clear for contour tones (e.g. Fox & Qi, 1990)

### Underlying mechanisms

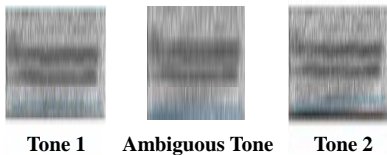
Mediated by perceived speaker identity (e.g. Moore & Jongman, 1997)  
Based on vocal tract information (e.g. Ladefoged & Broadbent, 1957)  
Driven by general auditory mechanisms (e.g. Holt, 2005)

### Hypothesis:

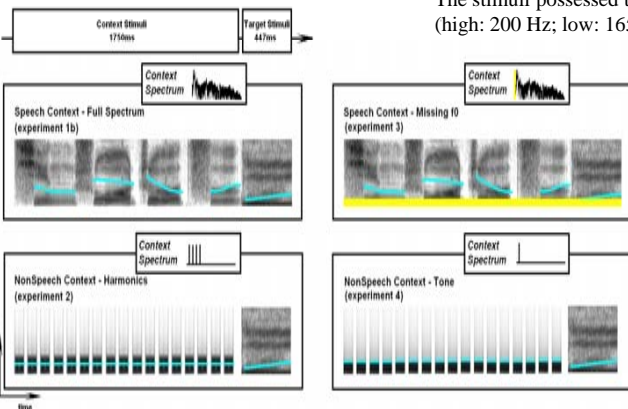
The perception of contour tones is also context dependent.  
General auditory mechanisms drive the “normalization” process.

## 2 Experiments

### Experiment 1a: No Context (Identification Task)



### Experiment 1b-4: Testing Context Influence (Identification task)

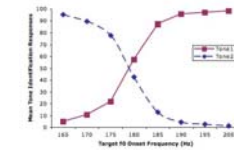


**Target Stimuli: Mandarin syllables /wu/, /yi/, /yu/**  
Stimuli are derived from natural recordings. An 8-step series varying perceptually from tone 1 to tone 2 was created for each syllable by manipulating the onset  $f_0$  frequency from 200 Hz to 165 Hz in 5 Hz steps. The  $f_0$  offset frequency for each stimulus was 200 Hz.

**Context Stimuli: Speech vs. NonSpeech**  
**Speech context: Mandarin sentence “qing3 shuo1 zhe4 ci2”**  
Stimuli are derived from recordings of the same speaker. Two versions of the sentence were created by shifting the entire  $f_0$  contour of the sentence (high mean  $f_0$ : 200 Hz ; low mean  $f_0$ : 165 Hz).

**NonSpeech Context: synthesized sine-wave tones**  
Each non-speech context was a sequence of 17 tones separated by 30-ms silent intervals; each tone was 70 ms.  
The stimuli possessed the same mean  $f_0$  frequency as the speech contexts (high: 200 Hz; low: 165Hz).

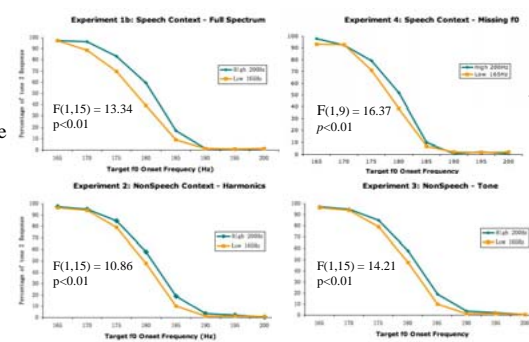
## 3 Results



$F_0$  onset frequency:  
 $F(7,15) = 326.74, p < 0.01$   
Tone 1 and tone 2 are well categorized; individual data were examined to ensure the regular categorization across  $f_0$  onset frequency series.

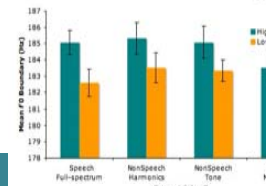
Speech contexts varying only on mean  $f_0$  elicit a context effect: lexical contour tones are also context dependent; and the direction is spectrally contrastive.

Nonspeech contexts mimicking some spectral characteristics elicit a similar context effect.



Speech context with no  $f_0$  energy elicit context effect:  $f_0$  information calculated from higher harmonics can also affect the perception of target stimuli.

Nonspeech contexts mimicking energy in solely  $f_0$  range elicit a context effect



**Boundary comparison of 4 context stimuli using Probit analysis**  
No Significant interaction between context stimuli and context frequency,  $F(3,15)=1.31, p=0.35$ .  
Influence of context on lexical tone identification was statistically indistinguishable in magnitude across the speech, non-speech harmonic, non-speech tone and missing  $f_0$  context types.

## 4 Discussion

- Mandarin listeners do make use of context in contour tone perception although contour tones vary on both  $f_0$  height and contour**
- The influence of context is spectrally contrastive**  
The high-frequency contexts (200 Hz mean  $f_0$ ) lead to more tone 2 responses (low onset  $f_0$ ), whereas the low-frequency contexts (165 Hz mean  $f_0$ ) lead to fewer tone 2 responses (more tone 1, high-frequency onset  $f_0$ , responses).
- General auditory mechanisms, rather than speaker identity or vocal tract information, drive the context effects in current study**

Two types of non-speech (harmonics and tone) context stimuli carrying no information for speaker identity or gesture information can also elicit context effects in contour tone perception of the same magnitude observed for speech contexts.

## References

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