



# The effect of tone exaggeration in Cantonese infant-directed speech on infant word recognition in the second year of life

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## INTRODUCTION

- The acoustic properties of infant-directed speech (IDS) have been widely discussed, such as the prosodic enhancement of pitch height and pitch range (Fernald et al., 1989; Fernald & Simon, 1984), and the exaggeration of phonemes including vowels ((Burnham, Kitamura, & Vollmer-Conna, 2002; Kuhl et al., 1997) and lexical tones (Liu, Tsao, & Kuhl, 2007; Xu Rattanasone, Burnham, & Reilly, 2013).
- Empirical studies have shown that infants benefit from the use of IDS, in particular with respect to its special prosody (Graf Estes & Hurley, 2013; Ma, Golinkoff, Houston, & Hirsh-Pasek, 2011) and exaggeration of vowels (Song, Demuth, & Morgan, 2010) in word processing. For example, Song et al. (2010) reported significant decrease in 19-month-old infants' performance in familiar word recognition when the expanded vowel space in IDS was reduced. However, little research has been conducted so far with respect to lexical tones.
- Lexical tones mark phonemic changes and alter lexical meanings in tone languages akin to vowels, whereas they are unique in term of being primarily instantiated by changes of pitch, a prosodic cue. Compared to vowels, young learners' sensitivity to lexical tones develops in a very distinct trajectory (Ma, Zhou, Singh, & Goh, 2017; Wewalaarachchi, Wong, & Singh, 2017).
- To examine the effect of tone exaggeration in IDS on infants' word processing is expected to provide new insights into the role of phonetic enhancement in speech input in early language acquisition.

## OBJECTIVES

- To investigate whether 19-month-old Cantonese-learning infants' familiar word recognition as one of the word-processing abilities would benefit from lexical-tone exaggeration in IDS.
- To further explore whether any facilitatory effect of tone exaggeration found in 19 month olds would diminish when testing older infants of 23 months old.

## METHOD

### Participants

- Monolingual Cantonese-learning infants:
- A 19-month-old group (N=21, Mean age =564 days, SD=14 days; 10 males);
- A 23-month-old group (N=33, Mean age =690 days, SD=22 days; 17 males).

### Stimuli

- The speech stimuli were Cantonese utterances containing target words familiar to the infants (see Table 1 and Table 2); they were originally recorded by a female Cantonese native speaker who was required to speak as if interacting with an infant.
- The target words were tested in pairs; the pitch of the lexical tones carried in each pair of target words were acoustically manipulated into two different conditions, i.e. the exaggerated-tone (ET) condition and the non-exaggerated-tone (NT) condition (see Table 2).

### Apparatus and procedure

- A Tobii TX300 eye-tracker was used to collect the fixation data. The intermodal preferential looking paradigm (IPLP) was used (see Table 1 for an example of one trial). Every subject completed both the ET and NT conditions.
- The percentage of the infants' fixation time to the target picture (the one corresponding to the word in the speech stimuli) in the salience phase and the test phase was calculated for each trial. The difference in the percentage of fixation time to the target between the two phases indexed the infants' performance in the trial. The data from all the trials of a condition were averaged.

	Duration (s)	Left side	Center	Right side	Speech stimuli
Attention getter			Baby face		Music
Familiarization phase	3				呢个系乜来嘍? 睇下呢个啊! (What is this? Look at this!)
	3				呢个系乜来嘍? 睇下呢个啊! (What is this? Look at this!)
Salience phase	3				呢的系乜来嘍? (What are these?)
Test phase- the first part	2				燈系边度啊? 燈! (Where is the lamp? The lamp!)
Test phase- the second part	2.5				

Table 1. A demonstration of the stimuli and the experiment procedure (taking one trial as an example).

Target word pairs	Gloss	IPA	Tone pairs	Pitch contrast in tone pairs (ET condition)	Pitch contrast in tone pairs (NT condition)
粥-肉	porridge-meat	[tsɔk]-[jɔk]	T1-T6	5.5 semitones	3 semitones
筆-襪	pen-sock	[pət]-[mət]			
窗-菜	window-vegetable	[tsʰœŋ]-[tsʰɔy]	T1-T3	4 semitones	2 semitones
羹-鏡	spoon-mirror	[kɛŋ]-[kɛŋ]			
燈-凳	lamp-stool	[tɛŋ]-[tɛŋ]			

Table 2. The pairs of target words, the lexical tones carried, and the pitch contrast in tone pairs in both conditions.

## RESULTS

### The 19-month-olds

- A paired t-test with the infants' different percentage of fixation time to the target between the test and salience phases as the dependent variable found a significant difference between the ET and NT conditions ( $t(20)=2.31, p=.032, d=.73$ ) (see Figure 1).
- In the ET condition, the percentage of the infants' fixation on the target increased significantly in the test phase as compared to the salience phase; in the NT condition, on the other hand, no significant difference was found between the test and salience phases (see Table 3).

### The 23-month-olds

- The paired t-test with the infants' different percentage of fixation time to the target between the test and salience phases as the dependent variable showed no significant difference between the ET and NT conditions ( $t(32)=.33, p=.74, d=.081$ ). (see Figure 1).
- In the ET condition, as was found in the 19-month-olds, a significant increase of the percentage of fixation time to the target in the test phase was detected as compared to the salience phase; in the NT condition, a marginally significant increase was found this time in the test phase compared to the salience phase (see Table 3).

	Percentage of fixation time to the target		Paired t-test
	The salience phase	The test phase	
<b>The 19-month-olds</b>			
ET condition	M=47.54%; SD=9.89%	M=54.86%; SD=13.49%	$t(20)=2.2, p=.04, d=.62$
NT condition	M=53.42%; SD=8.39%	M=50.26%; SD=10.59%	$t(20)=-1.08, p=.29, d=-.33$
<b>The 23-month-olds</b>			
ET condition	M=48.79%; SD=10.92%	M=56.34%; SD=10.19%	$t(32)=2.95, p=.006, d=.72$
NT condition	M=49.37%; SD=11.7%	M=55.58%; SD=11.58%	$t(32)=1.93, p=.062, d=.53$

Table 3. The percentage of the infants' fixation time to the target averaged across participants. Comparisons were made between the salience and test phases using paired t-tests in each condition for every age group. The results were reported along with the effect size (Cohen's d).



Figure 1. Violin-plots of the different percentage of the infants' fixation time to the target (between the test and salience phases) in the exaggerated-tone condition (ET) vs. the non-exaggerated-tone condition (NT). The dot and error bar represent the mean and standard error of the data. \*  $p < .05$ .

## CONCLUSIONS

- The 19-month-old Cantonese-learning infants performed differently in recognizing familiar words with and without the enhancement of tone contrasts in the speech input. The infants as a group succeeded when the acoustic contrasts of lexical tones of the word pairs were enlarged as in typical IDS, but failed when they were reduced and resembled those in ADS. These findings indicate that in the middle of the second year of life, tone-language learning infants' ability to recognize familiar words can be facilitated by tone exaggeration in IDS.
- In contrast, the 23-month-old infants performed comparably well in the word recognition task with and without the tone-contrast enhancement, suggesting that by the end of the second year of life, infants may largely reduce weight on the enhanced tone contrasts to recognize familiar words.
- Cross-language evidence was provided for the facilitatory effect of IDS in infant language acquisition.
- A developmental decrease of such effect was detected during the last half of the second year of life. It seems that the acoustic enhancement of tone contrasts facilitates infants' familiar word recognition mainly when infants are not proficient enough in doing the task.

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