A STUDY ON THE PROSODIC FEATURES OF INFANT-DIRECTED SPEECH IN MANDARIN CHINESE

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ABSTRACT

The present study explores the prosodic features of Mandarin ID speech by comparing it with AD speech based on the data from a longitudinal study. The aims of the study is to find whether ID speech of Mandarin Chinese has the prosodic modifications which were reported from a variety of languages and whether these modifications change across infants' age and gender. Results show that the mean F0 has a U-shaped function over infant age and pitch range decreased as the infants grew old. The mean F0 to boys is greater than that to girls while the pitch range to girls is greater than that to boys. Both the mean F0 and pitch range have a quadratic age trend.

Keywords: ID speech, AD speech, mean F0, pitch range

1. INTRODUCTION

Systematic investigation of the nature of speech addressed to infants and young children, often termed "motherese" or infant-directed speech, began in the 1960s from the study of Ferguson [1]. It is generally agreed that the language an infant hears is relevant to his language development. Socially isolated children who do not receive language input before a certain age, and profoundly deaf children who experience neither oral nor manual language, demonstrate severe deficits in acquiring language, or even do not acquire language, such as the examples mentioned in Fromkin, et al. [3] and Lane [8]. Normally developing infants can rapidly learn the sound categories of their native language, even though they do not receive explicit training.

In order to understand the development of child language, it is necessary to have a full account of the linguistic environment in which children are raised. Previous studies have provided evidence that IDS contained certain universal characteristics distinguishing it from ADS with respect to syntax and semantic features. Gallaway and Richards [4] summarize that the phonetic characteristics of IDS have been extensively explored by using a variety of methodologies and found to be different from ADS in several ways. It has reported that the most notable acoustic features of IDS in comparison to ADS are its higher pitch, wider pitch range, slower tempo, shorter utterances and longer pauses. Of the studies measuring the acoustic characteristics of IDS, most researches involve cross-language comparisons but few have involved ontogenetic manipulations. Building on previous studies, this paper will examine the acoustic features of Mandarin ID speech. Specifically, this paper addressed the following questions:

If mothers made prosodic adjustments when they interact with their children, does this kind of adjustment vary with children's age? Does it show any differences to children with different gender?

2. METHODOLOGY

The subjects are six mother-infant dyads, and they are audio- and video- taped at their home weekly in a naturalistic setting. According to Leaper, et al. [9], the gender effects are more likely to occur in naturalistic home environments than at the laboratory. There are equal numbers of boys and girls. These children are healthy and had no family history of physical disorder. Criteria for mothers participate in the speech recording are: firstly, Mandarin-Chinese is the mother's only or dominant language to her child; secondly, the mother is the primary caregiver of the infant and the mother has no physical or mental handicap.

The study uses the recordings when the infants are 9 months, 12months, 15 months, 18 months, 21 months and 24 months old and the adult directed speech samples are recorded between mothers and the experimenters when the infants are 18 months old. The audio recordings are digitalized into wave files with 16-bit resolution and a sampling rate of 44 kHz for segmentation and analysis. The

software of Praat and SPSS are used to analyze the data. The measures of mean F0 and pitch range are analyzed. Praat is used to get the pitch values for the further analysis. SPSS is used to compare the effect of each variable.

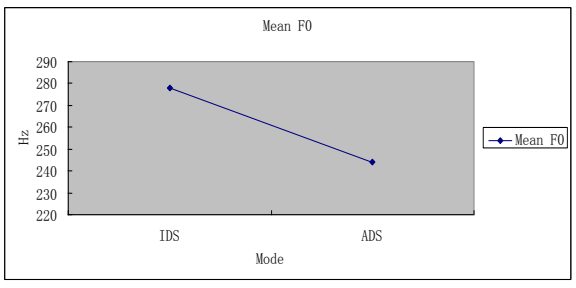
The wave forms of each session were segmented and recognizable utterances were extracted into separate files by using the software COOLEDIT. For each mother, 40 utterances from each session of her IDS and ADS are utilized. In all, there are 280 utterances per mother (7*40) for analysis on each measure. Based on Fernald and Simon's study [2], a recognizable utterance is defined acoustically as a section of speech bounded by pauses greater than 300ms of non-speech. Any utterances interrupted by background noises, or by the infant were omitted from analysis. Whispered speech, and non speech behaviors, such as laughter, nursery rhymes, and singing routines are also not included in the analysis.

Pitch range is converted from absolute Hertz to ratio pitch values using the semitone scale. Although F0 is presented as the acoustic correlate of pitch, it is necessary to note that the relationship between these two is logarithmic rather than linear. As Wu and Lin [10] pointed out, the perception of a change in pitch at different frequencies has been shown to be more closely related to proportional changes rather than to absolute changes in frequency. Therefore, converting to semitone allows comparisons between talkers with different fundamental frequency. F0 range is converted from Hertz to semitones using the formula, semitone = 12log2 (maximum F0/minimum F0). All these calculations are applied by using Praat scripts.

3. OVERVIEW OF THE RESULT

Figure 1 revealed the result of comparison made between ID speech and AD speech on the average fundamental frequency (mean F0). It showed that the average F0 in ID speech exceeded that in AD speech.

Figure 1: Mean F0 of ID speech and AD speech.

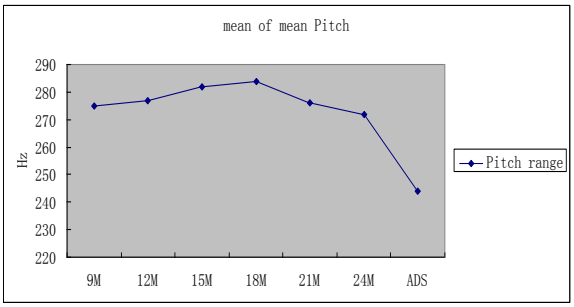


Pitch range, defined as the difference between the minimum and maximum frequencies, was also measured over the two speech modes after its values were converted to semitone. The one-way AVONA was conducted as the speech mode as factor. The result is that there is significant main effect of speech mode on pitch rang ($F=7.678$, $p=.001<.05$). This was consistent with previous study conducted by Grieser and Kuhl [5] which revealed that the prosodic features of Mandarin motherese are similar to that reported in other nontonal language. Mandarin speaking mothers also made some modifications when addressed their infant. The results here supported the statement that the prosodic characteristics of ID speech is universal and the intonation in Mandarin ID speech distinguish itself from that in AD speech with an overall higher mean F0 and greater pitch range.

A comparison of pitch correlates is conducted within IDS in order to test whether the prosodic modifications vary across infant age. Repeated measures ANOVA are conducted with age of infants as within-subject variable and post hoc comparison is conducted to find differences between every two age groups. Mauchly's test showed sphericity can be assumed for the effect of age. For the results of sphericity assumed, there is a significant difference on mean F0 between different age groups ($F=6.132$, $p=.000<.05$). It means the mean F0 of IDS changes across infant age and pot hoc comparisons reveal that the differences between Group 4 and Group 5 are quite significant ($p=.000<.05$). That is to say, big changes appear when infants are around 18 to 21 months old.

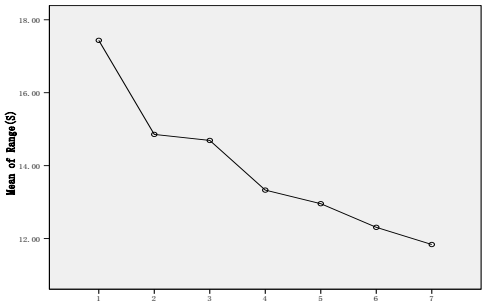
Figure 2 showed mothers' mean F0 across infant age. It revealed that mothers' mean F0 increased across age and is highest at 18 months, then decreased at 21 months.

Figure 2: Mean F0 for mothers across infant age.



The change of pitch range was also investigated. There were significant main effects for speech mode (F=23.049, p=.000<.05) and for infant age (F=10.628, p=.000<.05). Figure 3 displayed the change of pitch range for mothers at both speech modes and across infant age. Pitch range of ID speech decreased as the infant grows old. But in all, pitch range of ID speech is higher than that of AD speech. There was a linear age trend for pitch range. As shown in Figure 3, the pitch range decreased as infants grow up with the biggest change at 9 months to 12 months old and was expanded when mothers addressed to their infant contrary to adult.

Figure 3: Pitch range for mothers across infant age.

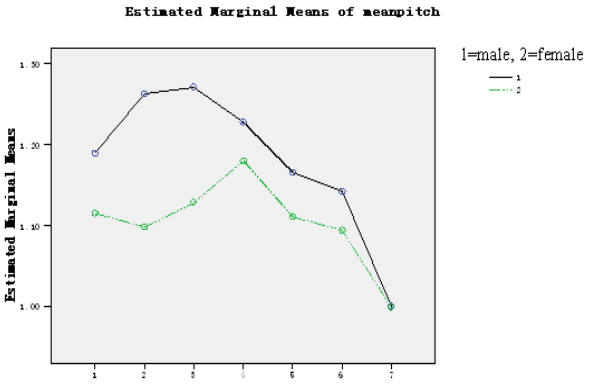


The results of comparisons of frequency correlates for this study are very close to that reported by Grieser and Kuhl [5]. Their value is a little larger probably because their calculation is based on a two-minute speech sample. Measuring over an entire two-minute sample typically produces a larger range than measuring each utterance, because it covers a longer period of speech. The major point is that the direction of the effect is consistent: pitch range is greatly expanded in speech directed toward infants.

Analyses were also conducted comparing mothers speaking to their male and female infants. For each of the two measures, mean F0 and pitch range, the main effects for the speech mode are the same as analysis already reported above. To normalize the acoustic measures, average levels of mean F0 and pitch range are calculated from each mothers' adult-directed speech. Proportions are derived by dividing mean F0 and pitch range of each IDS utterance of each mother at each infant age by her average adult levels of these measures. Results of AVONA showed that there was significant difference between the speech addressed to boys and girls (F=21.067, p=.000<.05). Mean F0 of mothers addressed to male infants is generally higher than that of mothers addressed to female infants.

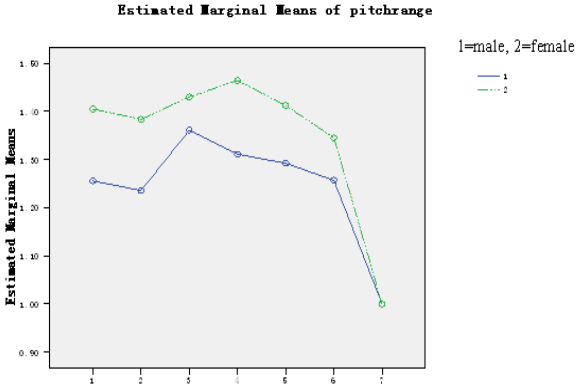
There was significant interaction between age and gender (F=4.040, p=.001<.05). This means that both the change of infant age and gender can cause the difference of mean F0. Figure 4 showed the age trend of mothers' mean F0. There was a significant quadratic age trend across the age. Mothers' F0 follows an inverted U-shaped function over age with peak F0 around 15 for male infants and 18 months for female infants and similar low levels of F0 at 24 months.

Figure 4: Gender-related mean F0 change across infant age.



The analysis was also conducted for the pitch range of different gender groups. There was a significant main effect for gender (F= 27.083, p= .000<.05). It showed that mothers expand their pitch range more when talking to female than male infants. That is to say, as shown in Figure 5, ID speech to female infants has much greater pitch excursions than that to male infants across all infant ages. The elevation of pitch range for girls over boys is at its maximum at 18 months. The degree of difference between girls and boys decreased across infant ages.

Figure 5: Gender-related change of pitch range across infant age.



4. DISCUSSION AND CONCLUSION

These results can be summarized as follows. As previous studies proved, mothers modified their speech when they talked to infants and ID speech has a higher mean F0 and pitch range. When infant age was taken into account, the mean F0 has a U-shaped function over age and pitch range decreased as the infants grew old. When infant gender was taken into account, the mean F0 to boys is greater than that to girls while the pitch range to girls is greater than that of boys. Both the mean F0 and pitch range had a quadratic age trend.

The properties of ID speech have been suggested by many researchers to be beneficial for language development. As Kitamura, et al. [7] puts it, there appear to be three main benefits to this specialized register. Firstly, it engages and maintains attention; secondly, it communicates affect and facilitates social interaction; and thirdly, it facilitates language acquisition.

Kitamura and Burnham [6] investigate pitch and communicative intent in mothers' IDS spoken to their infant in the first year. They find that the motherese contains messages of communicative intent to their infants and mothers adapt these messages according to the age and gender of their infants. Their results suggest that mothers differentially adjust mean F0 and pitch range to express various chances of communicative intent. Mean F0 is mostly associated with affective-type utterances such as positive affect, express affection, encourage attention, and comfort or soothe. Pitch range is associated with more directive ones such as encouraging attention and direct behavior. Overall, mothers adjust pitch and communicative intent in response to outward signs of development in the infant.

This might be a good explanation for findings in this study. Generally speaking, infants come to their babbling stage from 9 months and their perception of native speech sounds is becoming more selective and adultlike. This is a crucial age because referencing is emerging and infants can follow pointing gestures and instruction. Then at about 12 months, they speak out their first word and become more mobile. From about 9 to 18 months, infants are usually in the one word stage and master their first fifty words in this period. Their vocabulary development is relatively slow in this stage and parents would communicate more patiently and try to encourage them to speak as much as possible. From about 18 to 24 months, infants were in their two-word stage. Parents' focus shift from the content of infants' speaking to teach them using words and phrases to express ideas. This developmental change might explain the mean F0 peak which appeared at 18 months. As infants grow, they get more aware of the world and control themselves, the pitch range decreased. And this deserves a more detailed study.

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