

ACOUSTIC QUALITIES OF IDS AND ADS IN THAI¹

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ABSTRACT

Infant Directed Speech (IDS) samples were collected longitudinally from six mothers speaking to their infants (three with female infants and three with male infants) when their infants were newborns, 3 months, 6 months, 9 months and 12 months of age. Adult Directed Speech (ADS) samples of these mothers were also collected to be compared with these IDS samples. This maternal speech was then examined in terms of the phonetic characteristics, specially the prosodic aspects-pitch, tempo, and loudness. Twenty utterances from each of the six mothers speaking to their infants at each of the five ages and to an adult, totaling 720 utterances (20 utterances x 6 mothers x 6 age groups) were acoustically analyzed. They are fundamental frequencies, frequency ranges, utterance duration, syllable duration, numbers of syllable per utterance, and intensity values. Results of the comparison between IDS and ADS showed that IDS used higher fundamental frequencies (263.3 Hz vs 247.99 Hz), greater frequency range in semitones (15.16 st vs 13.5 st), shorter utterance duration (1106 ms vs 1506 ms), longer syllable duration (343 ms vs 220 ms), and less numbers of syllable per utterance (3.85 vs 7.63). Concerning the age-related changes of prosodic features, there seems to be three age intervals which show unique modification to the pattern of prosodic characteristics. The first age group is the newborns as opposed to other age groups, mothers use longer utterance duration, longer syllable duration, and more numbers of syllable per utterance. In the 3- and the 6-month-old periods, the mothers' speech style changes to an increase of the mean F₀ and pitch modulation. By the time the infants reach 9 and 12 months of age, there is a successive decrease of F₀ of the speech directed to the 6MO to the 9MO and the 12MO. Most prosodic features of the IDS directed to the 12MO are almost similar to those of the ADS. The study of intensity values in IDS fails to reveal any significant variation due to a general phonetic problem in the instrumental study of the degree of loudness in speech. The variations of the phonetic characteristics among the 6 groups in all aspects were statistically analyzed using the Analysis of Variance (ANOVA). It was found that every variation of the prosodic features investigated across age groups was statistically significant. It seems that these phonetic characteristics in the mothers' speech are adjusted to accommodate the communicative functions between the mothers and their infants and these functions have developed according to other developments of the infants.

1. INTRODUCTION

A good deal of past research on maternal speech has been done on phonetic and prosodic aspects of IDS (Cruttenden, 1994). Most earlier studies have focused on the prosodic features of maternal speech to children at older age, i.e., 16 months to 5 years (Remick, 1976; Garnica, 1977). Some studies have done on the prosody of maternal speech during the first year of life (Fernald, 1978; Greiser & Kuhl, 1988), but no age comparison. However, there is only one work which has been done systematically concerning changes in prosody of maternal speech to infant during the neonatal period and at 4, 12, and 24 months and compared them to speech addressing an adult (Stern, Spieker, Barnett & Mackain, 1983). In this study, a longitudinal investigation of infant directed speech will be done systematically and compared to adult directed speech. Past studies have revealed that IDS uses higher mean pitch and wider pitch range (Ferguson, 1964; Remick, 1976; Garnica, 1977; Stern et al., 1983; Fernald, Taeschner, Dunn, Papousek, De Boysson-Bardies & Fukui, 1989; Kitamura, 1992; Khaonoo, 1996). It also contains slower articulation rate of speech, shorter utterances, and fewer syllable (Drach, 1969; Broen, 1972; Sach, Brown & Salerno, 1976; Garnica, 1977; Stern et al., 1983; Greiser & Kuhl, 1988; Fernald et al., 1989). Another prosodic aspects of IDS is the use of whispering (less volume in voice) (Garnica, 1977). It is not clear whispering is related to the degree of loudness in IDS. This aspect of loudness needs to be explored. Therefore, in this research we explore whether the presence and distribution of the prosodic aspects- pitch, tempo, and loudness of IDS differ systematically from their distribution in ADS.

2. RESEARCH METHOD

2.1. Data Collection

The speech samples of IDS were recorded from 12 mothers of newborns and again from the same mothers when their children were 3, 6, 9, and 12 months. In addition recordings were taken of the same mothers speaking to the researchers in the consultative style. At the newborn stage, samples were recorded in the Charoenkrung-pracharak and the Police hospital by using a Sony Professional Walkman tape recorder. The researchers instructed the mothers how to use the tape recorder and asked them to do a 20 minutes recording when talking to their children during play time or changing diapers. The tapes were then collected before they

left the hospital. Samples at 3, 6, 9, and 12 months were collected using the same procedure as that with newborns but recording were conducted in the home of the subjects. Samples of ADS were collected from interviews with the mothers by the researchers for about 20 minutes at 12 months when the researchers were quite accustomed to the mothers now. The style of speech used was casual consultative style. Six mothers of infants were chosen randomly, three with female infants and three with male infants participated in this study.

2.2. Subjects

The subjects are six mothers of infants, half of them consists of mothers of male infants and the other half consists of those of female infants. All mothers belong to the middle socio-economic class. They all at least, got a bachelor degree and speak only standard Thai at home.

2.3. Data Analysis

A totaling 120 minutes (20 minutes x 6 age groups) for each mothers of each of the six mothers were collected (20 minutes each of newborn IDS, 3 months-old IDS, 6 months-old IDS, 9 months-old IDS, 12 months-old IDS, and ADS). They were transcribed into utterances by using auditory pauses as a marker to delimit them. For phonetic analysis, a subsample of the total samples, 20 speech utterances which occur in the second discourse topic of 3MO IDS, 6MO IDS, 9MO IDS, 12MO IDS, and ADS were used. Except the 20 utterances of the NB IDS, the researcher had to choose the utterances which were perceived as a good sound quality from most of the recordings because the sound quality of the recording was quite poor at this age. Thus a total of 720 utterances ($20 \times 6 \times 6 = 720$) were analyzed acoustically using Multi-Speech (MS) Model 3700 for the measurement of fundamental frequency, duration, and intensity.

- Pitch measures. The descriptions of pitch-mean- F_0 and pitch range of mothers' speech directed to their infant across six ages. Mean- F_0 was calculated in hertz (Hz) by computer. F_0 -range was derived from the difference between the maximum F_0 and minimum F_0 converting to semitones.
- Tempo measures. Three measures of tempo across six age groups were done : average utterance length, average syllable-length, and number of syllable per utterance.
- Intensity measures. The mean intensity was calculated automatically in decibel (dB) by the computer.

3. RESULTS

3.1. Pitch

In this study, 720 utterances were analyzed in terms of fundamental frequency. A total number of measurements of fundamental frequency across age groups made was 170,166.

Across infant age groups, there is a large increase of F_0 in NB and the 3MO (250 to 276 Hz). There is a successive decrease of F_0 for the IDS of the 6MO (278Hz) to the 9MO (265Hz) and the 12MO (247Hz). IDS of mothers to the 12MO has the overall pitch which is almost similar to that of ADS (247 Hz vs 248 Hz) as illustrated in Figure 1 below.

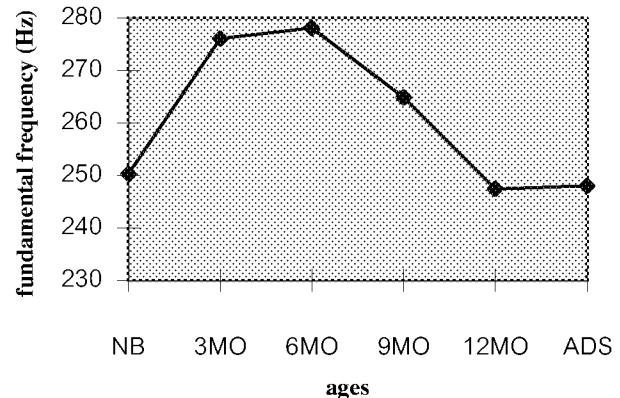


Figure 1: Mean Fundamental Frequency across Age Groups

The Analysis of Variance has been executed to test whether the variations are significant or not. The mean fundamental frequency of IDS is significant higher than ADS which is 263.3 and 247.99 respectively. The average pitch shows significant age changed, $F(5,170,154) = 878.220$, $p < 0.05$.

For the pitch range, the findings show that pitch range is expanded when mothers direct their speech to infants as opposed to adults. The average range per utterance is 15.16 in IDS and 13.5 in ADS. A one-way ANOVA shows that the average range per utterance in IDS is significant higher than ADS, $F(1,718) = 7.394$, $p < 0.05$.

3.2. Tempo

In the tempo analysis, the duration of utterance, duration of syllable, and numbers of syllable per utterance were investigated and reported in Table 1 below.

| | NB | 3MO | 6MO | 9MO | 12MO | Mean IDS | ADS |
|-----|------|------|------|------|------|-------------|------|
| MLU | 1262 | 1115 | 950 | 1102 | 1104 | 1106 | 1506 |
| MLS | 359 | 351 | 333 | 341 | 328 | 343 | 220 |
| MNS | 4.36 | 3.75 | 3.08 | 3.87 | 4.33 | 3.88 | 7.63 |

Table 1: Mean utterance length (MLU), Syllable length (MLS), and Numbers of Syllable per Utterance (MNS)

In utterance duration analyses, ADS use significant longer utterance length than IDS (1506 ms vs 1106 ms), $F(1,718) = 18.203$, $p < 0.05$. The utterance duration also changes significantly with infant age, $F(5,708) = 5.176$, $p < 0.05$.

Regarding to syllable duration, IDS contains significant longer syllable length than that of ADS (343 ms vs 220 ms), $F(1,718) = 31.025$, $p < 0.05$.

In terms of the number of syllable per utterance, ADS contains significant more average syllables than IDS (7.63 vs 3.85), $F(1,718) = 87.494$, $p < 0.05$. The average number of syllables per utterances is equal at 4 syllables per utterance in all ages except at 6-month-olds which the average is lower equal at 3 syllables.

3.3. Loudness

The findings on intensity measures oppose to the hypothesis. The mean intensity in IDS should be lower than ADS but it does not follow this. That is to say, the intensity values is 71.28 dB for IDS and 69.07 dB for ADS. This is because there is a problem in the measurement methodology. The results reveals the opposite way to the auditory judgment. Indeed, we notice very soft degree of loudness in IDS than ADS. The speech of IDS has very low intensity. So, it cannot be registered by acoustic analyzer. We have to increase the speech intensity by increasing the input volume until the machine registers the signals. Therefore, the intensity results are not valid.

4. DISCUSSION

The findings of acoustic analyses in Thai support the universal theory of prosodic features in motherese. Especially, results for pitch analyses: mean pitch and pitch range are similar to that reported in other languages as shown in Table 2 adhered at the end of this paper. Although these languages represent considerable diversity in prosodic structure, they display the higher pitch and expanded pitch range in IDS compared to ADS. For example, American English, British English, Australian English, and German are all stress languages, while French uses syllable timing and duration to indicate stress. Italian makes greater use of variability in word order and emphasis is marked more frequently by fronting the focuses word. In contrast, Japanese is a pitch accented language using particles instead of prosodic marking to emphasize words. Mandarin and Thai are both tone language which a change in pitch contour changes the meaning of the word. However, these languages reveal different degree to which mothers use in pitch modulation to their infants. American English mothers in the work of Fernald et al. (1989) shows greater extent of intonation exaggeration in speech to infants (308 Hz) and higher pitch modulation (19.2 st) (Garnica, 1977), while Thai mothers use the lowest mean pitch in IDS (236 Hz) (Khaonoo, 1996) and Mandarin mothers use more subdued in pitch modulation to their IDS (5.1 st) (Greiser & Khul, 1988). Although Mandarin and Thai are both tone language, Mandarin mothers use more higher pitch when addressing to their children than Thai mothers. This is because the toneme inventory of Mandarin is quite different from the inventory of Thai tones. Mandarin has only one static tone- the high but 3 kinetic tones, the fall, the rise, and the low-rise. Thai has 3 static tones, the high, the mid, and the low, and 2

kinetic tones with very distinctive direction, the fall and the rise. We may hypothesize here that Thai speakers cannot vary their pitch as much as the Mandarin speakers because they have to keep the 3 static toneme inventory distinctive. Further research should be done on other tone languages which have different tone inventories to test this hypothesis. Regarding duration, in this study we investigate both utterance duration and syllable duration. Utterance duration reveals the similar results as other works. For syllable duration, no work has been done to compare between IDS and ADS. The numbers of syllable per utterance analyses resemble the work of Stern et al. (1983). That is to say, ADS contains significant more average syllables than IDS (8 vs 4). The intensity results are not valid. This is a problem which needs to be solved by improving the acoustic analyzer so that a wide range of intensity from very low to very high can be registered without increasing the input volume.

Note¹: This study is based on the IDS data of 12 mothers belong to the extensive collaborative research program on mother-child interaction between the Infant Research Center, the University of New South Wales and the Linguistics Research Unit, Chulalongkorn University.

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| | Mean F0/utterance (Hertz) | | | Mean F0 range/utterance (semitones) | | | Mean utterance duration (second) | | |
|---------------------------|---------------------------|-----|------|-------------------------------------|------|------|----------------------------------|-----|------|
| | IDS | ADS | DIF* | IDS | ADS | DIF* | IDS | ADS | DIF* |
| English | | | | | | | | | |
| American English | | | | | | | | | |
| (1)Garnica (1977) | 267 | 198 | 69 | 19.2 | 10.5 | 8.7 | - | - | - |
| (2)Stern et al. (1983) | - | - | - | 9.6 | 8 | 1.6 | 0.6 | 1.2 | 0.6 |
| (3)Fernald et al. (1989) | 308 | 206 | 102 | 11.3 | 8.7 | 2.6 | 1.3 | 2.3 | 1 |
| British English | | | | | | | | | |
| (1)Fernald et al. (1989) | 262 | 222 | 40 | 11.4 | 10.7 | 0.7 | 1.1 | 1.9 | 0.8 |
| Australian English | | | | | | | | | |
| (1)Kitamura (1992) | 273 | 222 | 51 | - | - | - | - | - | - |
| (2)Kitamura (in progress) | 285 | 217 | 68 | 13.7 | 12.9 | 0.8 | 1.8 | 2.3 | 0.5 |
| German | | | | | | | | | |
| (1)Fernald & Simon (1984) | 257 | 203 | 54 | 11 | 3.5 | 7.5 | 1.1 | 2.2 | 1.1 |
| (2)Fernald et al. (1989) | 241 | 207 | 34 | 12.4 | 9.8 | 2.6 | 1.5 | 2.6 | 1.1 |
| French | | | | | | | | | |
| (1)Fernald et al. (1989) | 288 | 242 | 46 | 11.8 | 9.6 | 2.2 | 1.3 | 1.7 | 0.4 |
| Italian | | | | | | | | | |
| (1)Fernald et al. (1989) | 266 | 223 | 43 | 12.8 | 9.5 | 3.3 | 1.6 | 2 | 0.4 |
| Japanese | | | | | | | | | |
| (1)Fernald et al. (1989) | 277 | 207 | 70 | 8.1 | 9.0 | -0.9 | 1.3 | 2.6 | 1.3 |
| Mandarin | | | | | | | | | |
| (1)Greiser & Khul (1988) | 247 | 199 | 48 | 5.1 | 3.5 | 1.6 | 1.1 | 1.7 | 0.6 |
| Thai | | | | | | | | | |
| (1)Khaonoo (1996) | 236 | - | - | - | - | - | - | - | - |
| (2)Thanavisuth (1997) | 263 | 248 | 15 | 15.2 | 13.5 | 1.7 | 1.1 | 1.5 | 0.4 |

Table 2: Cross-language comparison on the prosody characteristics of IDS and ADS

*DIF means the differences between IDS and ADS