

Acoustic characteristics of Motherese

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ABSTRACT

Objective: This study aims to investigate the speech rate, the length of a pause, habitual pitch, and voice intensity of motherese. **Subjects and Methods:** The research participants comprised 20 mothers (mean age 33 years). Speech data were collected and analyzed using the Real-time Pitch software (KayPENTAX®). **Results:** The average speech rate was 5.33 syllables per second without their infant present and 4.26 syllables per second with their infant present. The average pause length was 1.09 s without their infant present and 1.56 s with their infant present. The average habitual pitch was 199.79 Hz without their infant present and 227.15 Hz with their infant present. The average voice loudness was 61.09 dB without their infant present and 64.49 dB with their infant present. **Conclusion:** This study presented clinical information for efficiently managing the speech therapy issues of infants and children. This includes proper acoustic and phonological information to recommend to main caregivers.

Keywords: habitual pitch, loudness, motherese, overall speech rate, pause duration

1. Introduction

When adults talk to infants, they use a different language form than the one used when conversing with other adults. This language form is called baby-talk. According to the linguist Ferguson [1], baby-talk can be defined as “a subsystem of language that is used when suitable to take care of young children.” In previous studies, baby-talk has been referred to variously as caretaker speech, infant-directed speech (IDS), child-directed speech (CDS), motherese, parentese, mommy talk, and daddy talk, and is called “Mother talk [Omma Mal],” or “Mother’s voice language [Mosung-uh]” in Korea [2].

From a linguistic perspective, mother talk has syntactic and

secondary-language characteristics [3]. Syntactically, mother talk has a short mean length of utterance (MLU) and contains more content-based words than function-based words. Secondary language traits include a high pitch and exaggerated accents. This is also the case from a perceptual perspective – babies, too, prefer high-pitched, rhythmically intonated mother-talk patterns to monotonous speech [4]. Based on these findings, many studies have taken acoustical approaches to quantify and objectively observe mother talk.

The findings of these studies are as follows. First, mother talk tends to be rather slow. Kim Ji Won [5] compared the speech rate of mothers and nursing teachers using interrogative and declarative sentences with real-life and imagined 4- to 6-year-old toddlers, and found that they spoke at an average speech rate of 4.62 syllable per second (SPS) when talking to real-life toddlers, but at 5.27 SPS when talking to imagined toddlers. In addition, Fisher and Tokura [6] conducted a study in which they compared the speaking speed of 20 mothers when talking to 14-month-old infants, as opposed to when they talked to adults. The results showed that the mothers took an average of 244 msec when talking to infants but 168 msec when talking to adults, demonstrating that they spoke more slowly to children. In addition to speech rate, Fernald and Simon [7]

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Received: November 14, 2014

Revised: December 8, 2014

Accepted: December 19, 2014

observed pause length in mother talk and measured the fundamental frequency, articulation rate, and pause length of mother-adult (adult talk) and mother-infant (mother talk) talk. In mother-adult conversations, the pause length was measured at 0.8 seconds, while in mother-infant conversations the pause length was 1.5 seconds longer.

The habitual pitch of mother talk also differed between various circumstances. Warren-Leubecker and Bohannon [8] analyzed the fundamental frequency and pitch range of mother talk using 2-year-olds, 5-year-olds, and adults as subjects. With 2-year-olds and 5-year-olds, the fundamental frequency of mother talk was 222 Hz and 223 Hz respectively, showing that the increase in toddler age did not affect frequency. With adults, on the other hand, the fundamental frequency was 206.75 Hz, lower than the frequency used with toddlers. Fisher and Tokura [6] studied the maximum and minimum pitch frequency used in mother talk and found it to range from 289.43 Hz (maximum) to 196.17 Hz (minimum). In adult conversations, the frequencies ranged from 233.464 Hz (maximum) to 158.94 Hz (minimum), showing that the frequency range of mother talk was noticeably wider than that of regular speech. Finally, in conversational situations, the fundamental frequency of mother-adult conversations was found to be 203 Hz while that of mother-infant conversations was 257 Hz [7]. The pitch of motherese is generally higher than adult-directed speech [6-8]. It is well-known that the increased pitch is closely related to the loudness in voice.

Based on the findings of the aforementioned studies, this study recorded 20 mothers reading a passage with and without their children present. The mothers' speech rate, pause duration, habitual pitch, and loudness were investigated under these two conditions.

2. Methods

2.1 Subjects

The subjects of this study comprised 20 mothers with 12- to 48-month-old normally developing infants. The results showed statistically no difference according to the age of infants. The mean age of the mothers was 33±2 (see Appendix). The standards for choosing the subjects were based on studies by Owens [9], as follows: (1) The infants showed normal levels of physical, emotional, and linguistic development; (2) the mothers had normal levels of physical, neurological, emotional, and linguistic development; (3) the area of residence/place of birth

from which the subjects were selected was restricted to the Gangwon Youngseo District, so as to limit acoustical differences arising from dialect difference; (4) the subjects were full-time stay-at-home mothers; and (5) the mothers came from middle-class families.

2.2 Test Tool

In consideration of the age of the participating infants, a sentence from the story "The Hare and the Tortoise" was selected for the recording. The sentence consisted of 45 syllables, and the overall speech rate, pause duration, habitual pitch, and loudness were recorded and analyzed. A directional microphone (SHURE SM48) was connected to an Real-Time Pitch software (Model 5121) of KayPENTAX to record the voice at sampling rates of 44,000 Hz.

2.3 Procedure

Speech rate, pause duration, habitual pitch and loudness were measured in two situations i.e., (a) one with infant (b) another without infant, but pretending as if they were in front of the infants. The speech recordings were conducted individually in a quiet room. The reading passage was chosen from the storybook "The Hare and the Tortoise," and were consisted of both interrogative and declarative sentences in Korean as follows:

그렇지만 누가 가겠어요? 물고기도 문어도 땅에선 살 수가
없잖아요 그 때 자라가 씩씩하게 말했어요
“제가 가겠습니다.”

But who would go? Neither fish, nor octopus, nor whales can live on land. Just then, the tortoise bravely said, 'I will go.'

Prior to recording, the content and process were explained to a subject, and she is given the reading material. The subject was then asked to read at her most comfortable level of loudness and pitch, and the distance between the microphone and the subject's mouth was maintained at about 10 cm. The recordings were taken under two conditions, once with the infant present and once without. The subject repeated the sentence three times and took 30-second breaks in between each reading.

2.4 Data Analysis

A comparative analysis of the overall speech rate, habitual pitch, and loudness was conducted using Real-Time Pitch

(Figure 1). The overall speech rate was calculated using the total speaking time taken to read the 45 syllables. Typical pauses of over two seconds (2000 msec) or stuttering were excluded from the total speaking time. Pauses were included when they lasted for at least 0.15 seconds (150 msec); if more than one pause occurred, they were added together and measured. Background noises, coughing, sighing, and breathing were all included in the calculation of pause duration. Habitual pitch and loudness were analyzed using average values.

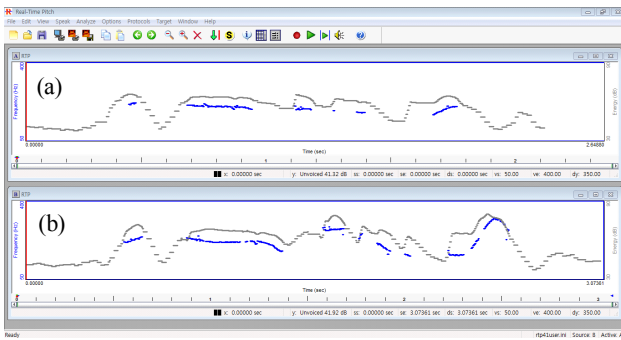


Figure 1. Examples of acoustic analysis (a) Reading a book without infant, (b) Reading a book to infant

2.5 Statistical Analysis

The data were divided into two sets, according to the presence or absence of infants while reading. SPSS 21.0 for Windows was used to analyze the two data sets. The Wilcoxon Signed Rank Test was used for analysis, and the level of significance was set at 0.05.

2.6 Reliability

For the reliability verification of the analyzed data, about 20% of the voice data was randomly selected to assess the intra-rater reliability. The intra-rater reliability of measurements was as follows: speech rate, 99.47%; pause duration, 99.34%; habitual pitch, 99.38% and Intensity, 99.21%.

3. Results

3.1 Overall speech rate

A comparison of the average overall speech rate for the two groups is presented in Table 1 and Figure 2. These show that the overall speech rate for mothers was 5.33 SPS when reading without infants, but only 4.26 SPS when reading with infants present, thereby showing ($p < 0.05$) that overall speech rates are slower when reading to infants.

3.2 Pause duration

A comparison of the average pause duration in the two groups is presented in Table 1 and Figure 2. These show that the average pause duration was 1.09 seconds when reading without infants but 1.56 seconds when reading with infants, thereby showing ($p < 0.05$) that pause durations are longer when reading to infants.

3.3 Habitual Pitch

A comparison of the average habitual pitch in the two groups is presented in Table 1 and Figure 2. These show that the average habitual pitch for mothers was 199.79 Hz seconds when reading without infants but 227.15 Hz seconds when reading with infants, thereby showing ($p < 0.05$) that habitual pitch is higher when reading to infants.

3.4 Loudness

A comparison of the average loudness of speech in the two groups is presented in Table 1 and Figure 2. These show that the average loudness of mothers was 61.06 dB when reading without infants but 64.49 dB seconds when reading with infants, thereby showing ($p < 0.05$) that mothers speak more loudly when reading to infants.

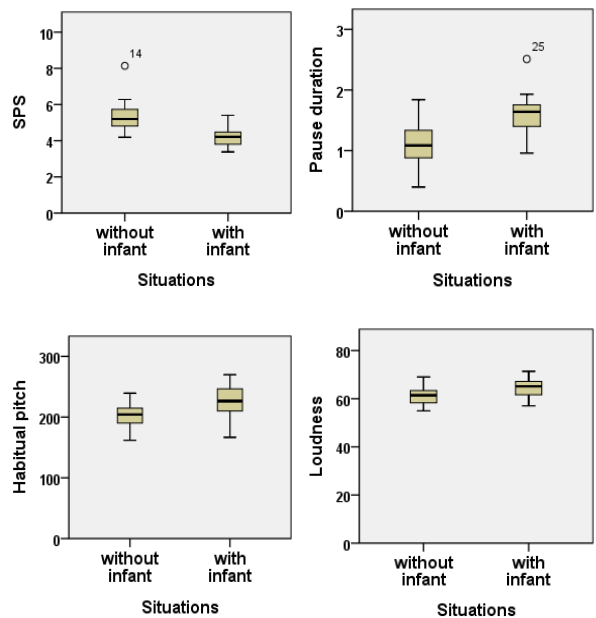


Figure 2. Acoustic characteristics between situations

Table 1. Acoustic characteristics of motherese between situations

Measures	Situations		Z
	Reading a book without infant Mean ± SD	Reading a book to infant Mean ± SD	
Overall speech rate (SPS)	5.33 ± 0.88	4.26 ± 0.58	-3.529***
Pause duration (sec)	1.09 ± 0.32	1.56 ± 0.34	-3.772***
Habitual pitch (Hz)	199.79 ± 20.47	227.15 ± 24.68	-4.015***
Loudness (dB)	61.06 ± 3.68	64.49 ± 3.91	-3.563***

* $p < .05$ ** $p < .01$ *** $p < .001$

4. Discussions and Conclusions

The current study took 20 females with infants of 33±2 months of age on average, observed their acoustical characteristics when reading with and without the infants present, and analyzed their overall speech rate, habitual pitch, and loudness. The following conclusions were obtained from the results.

Firstly, speech rate was found to be statistically and significantly slower when reading to infants (4.26 SPS) than when reading without infants (5.33 SPS). This conforms to results obtained in previous studies, which show that mother talk is slower than adult talk [5-7]. In addition, when measuring pause durations in both conditions, they were shown to be statistically and significantly longer when reading to infants (average duration = 1.56 seconds), than when reading without infants (1.09 seconds). This finding coincided with the results of previous studies [7]. When reading or talking to infants and toddlers, adults consider the language development of the infants in question and, to maintain the infants's focus, slow down their speech rate and increased pause duration [5-7]. This result can be interpreted in terms of infant's voice preference. According to Hirsh-Pasek et al. (1987), 7-10-month-old infants preferred adults voice with pause [13].

Secondly, regarding habitual pitch in different situations, it was found to be statistically and significantly greater when reading to infants (199.79 Hz) than when reading without infants (227.15 Hz). This result mirrors that of previous studies [5-8,10], and is significant in that it shows that the pitch of mother talk plays a crucial role in infant's language development [11]. From a clinical perspective, it may be more effective for speech-language pathologists who treat children to use various pitch ranges, as this may increase the efficiency of

treatment by inducing the said children to focus. Using high pitches and a wide range of pitches in linguistic stimuli for children may also prompt the children to focus [10]. The mother's pitch is relevant to change of intonation. Cooper and Aslin [14] claimed that infants were preferred high pitch to monotone of motherese pattern. Autism infants also responded to noticeable intonation frequently [17]. Morgan [15] observed that mother's prosody can contribute to infant's early language and sentence comprehension ability. That is, the change of motherese's pitch affects infant's language development.

Thirdly, loudness of speech was shown to be statistically and significantly greater when reading to infants (64.69 dB), than when reading without infants present (61.06 dB). From a physiological perspective, adults need to make physiological changes, such as increasing vocal fold contact, subglottal pressure, respiration volume, and the tension of the vocal folds, when performing in a play, making a speech or presentation, or singing [12]. That is to say, through these processes, we produce louder voices and attract more attention from our listeners. Thus, for mother talk, too, louder speech may be produced in order to attract infant's attention. It has been found that the increase of loudness in voice is associated with speech intelligibility. As suggested by Raming [16], acoustically and aero-dynamically improper voice is quite bad for our speech intelligibility. This result indicated that voice and loudness of motherese can directly affect communicating information to infant. That is, loudness is one of the important factors in mother's communication with infants.

The limitations of this study and suggestions for future research are as follows. The current study measured data from a single context - a reading passage; future studies should analyze mother talk in more varied contexts. The acoustical differences in mother talk according to the sex of the infants should also

be studied, and acoustical characteristics of the mother talk used by various care-givers should be analyzed.

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Appendix

Information of subjects

	Age of mother (year)	Residence periods (year)	Educational Level	Income level (10,000 won)	Age of infant (month)	Gender of infant
1	31	31	University graduate	250-300	12	M
2	30	30	University graduate	400 ≤	14	M
3	31	19	University graduate	250-310	35	M
4	31	25	University graduate	220-290	37	M
5	33	33	University graduate	250-330	38	M
6	32	20	University graduate	400 ≤	38	M
7	33	33	University graduate	290-400	40	M
8	34	18	High School graduate	330-380	48	M
9	34	34	High School graduate	250-350	31	M
10	31	31	High School graduate	300-400	12	M
11	29	23	University graduate	215-280	12	F
12	34	25	University graduate	230-330	47	F
13	33	33	University graduate	300-400	35	F
14	34	34	University graduate	320-350	42	F
15	31	31	University graduate	300-370	45	F
16	37	30	High School graduate	400 ≤	46	F
17	30	23	High School graduate	300-350	12	F
18	33	33	High School graduate	250-300	14	F
19	37	30	High School graduate	300-350	32	F
20	34	20	High School graduate	350-450	39	F