A STUDY OF MANDARIN SEGMENTAL AND MONOSYLLABIC INTERVALS OF CB AND EARLY SPEECH

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ABSTRACT

Regarding the changes of segmental and monosyllabic intervals in child CB (Canonical Babble) and early speech, it was hypothesized that decreases in interval would be greater when children are younger and there would be smaller decreases when they are older. A number of cross-sectional researches support this hypothesis, but the result of some other researchers proves to be the contrary. Thus it has become an issue. Most acoustic investigations concerned are conducted via cross-sectional designs and focus on word stages rather than on the emergence of speech from babbling to word stages. Therefore, this issue needs more longitudinal investigations.

We conducted an acoustic study of temporal characteristics of segments and monosyllables concerning CB and early speech in a Changsha infant (LJ) aged from 0;9 to 2;4 acquiring Southern Mandarin. Our result doesn't support the above hypothesis. The findings are: 1) Not all segments and monosyllables in CB and early speech are expected to follow the hypothesis; 2) The patterns of duration decrease in segments and monosyllables prove to be unsystematic; 3) There is a tendency of gradual decrease in segmental and monosyllabic duration with the growing age; 4) Our findings are in support of the continuity view.

Keywords: interval, segment, CB, monosyllable, continuity view

1. INTRODUCTION

A number of cross-sectional studies regarding acoustic characteristics of children's early speech development found that intervals of segments, syllables, words and phrases tend to decrease as children are getting older. The hypothesis assumed that decreases in interval would be greater when children were younger and decreases would be smaller when they were older [13]. It has been supported by some researches on the basis of cross-sectional studies [2, 6, 14], but the result of some other researches is not in support of this hypothesis [12]. Their data prove to be the contrary. The longitudinal analysis of certain acoustic characteristics of the speech of 12 children over a period of about one and a half years showed that some older children gained rather substantial decreases across time compared to younger children. This issue is left unresolved. Most acoustic investigations of children's speech production have been conducted via cross-sectional designs which involve studying several groups of children. Therefore, this issue needs more longitudinal investigations. Moreover, all former cross-sectional studies are without reference to either babble or word stages. In examining the early part of speech development, we come to think of an interesting and important phenomenon called babble.

Babbling is defined as reduplicated sequences of consonants and vowels. According to Oller, et al. [10], if a vocalization consists of a consonant and a vowel, infants have entered the canonical babbling (CB) stage. CB is characterized by the production of well-formed syllables that have adultlike spectral properties [5, 9].

On language development, there exist two kinds of opposing views. Some researchers [4, 7] assumed discontinuity between babbling and speech. However, the notion of continuity between babbling and early speech is widely supported by empirical studies. Brown [1] put forward 'babble drifting hypothesis', which asserts that infants' babbled utterances tend progressively to resemble the phonetic characteristics of the language to which they are exposed across the first year or so of life under the influence of ambient language. Several studies have suggested that CB and early speech development are closely related. According to Oller [8] (quoted from Roug, et al. [11]), CB is the first stage in which the child produces syllables that conform to natural language restrictions, the syllables that could be accepted from a phonological point of view. The onset of CB is a landmark event in infants' vocal development for spoken language [3].

The current research addresses the following two questions:

1. Whether decreases in interval would be greater when children were younger and there would be smaller decreases in interval when they were older?

2. Whether babble drifts in the direction of the speech the child is exposed to and the stages of CB and early speech are continuous or discontinuous?

2. METHOD

2.1. Subject

This is a longitudinal case study of a Changsha infant aged 0;9 to 2;4 acquiring Southern Mandarin. She was the first infant born to a well-educated family. The infant was very healthy and normal in hearing. She exhibited no delay in cognitive skills, receptive language, nonverbal communicative skills or unusual prenatal, sensory, or developmental concerns. She was a monolingual child. At home, her parents and other caregivers as well as her peers communicate with her in Southern Mandarin. The infant was easy-going and enjoyed interactions with others.

2.2. Recording procedure

The infant was video-recorded by using the camcorder SONY HDR-HC1 with an integrated microphone. She was recorded at 16-bit and at a sampling rate of 44,000 samples per second. The camera was held at a reasonable distance so as not to distract the infant from her free activities, while ensuring proper capture of the sounds produced by the infant. She was also audio-recorded by using the sound recording pen (SONY ICD-SX35) and it was held at about 10 to 18 inches away from the infant's mouth. Video and audio-recordings of about 45 minutes and one hour were made under natural observation. All the recordings were transferred to a PC for segmentation and analysis. The audio-recordings were converted into the form 'wav' by using the CoolEdit Pro.2.0. The data came from HICSD (Hunan Infant Children Speech Database) funded by Hunan University.

2.3. Phonetic transcription and reliability

Segments and syllables from 46 sessions spanning the transition from babble to early speech were transcribed in IPA and coded for analysis. Babble was coded from age 0;9-1;0, and words were coded from 1;0 to 2;4. The data were checked by two professionally trained persons who majored in Mandarin Chinese phonetics. Our intra-evaluator reliability was up to 98% and inter-evaluator reliability was 91%. CB covers 0;9-1;0 and early speech stages include 1;1-1;5, 1;6-2;0, 2;1-2;4.

2.4. Selection of segments and monosyllables

We chose the unaspirated stops /p/, /t/, /k/; nasals /m/, /n/; glides /j/, /w/ and monosyllables /pa/, /ta/, /ka/, /ma/, /na/, /wa/, /ja/ from late babble and early speech for analysis. Those chosen are the ones that appear in each stage. It is very hard to match the aspirated voiceless stops due to their low frequency, so they are not included. The number of tokens from each stage is 50 concerning the segments and monosyllables respectively. We used Praat to do textgrids of them and a reliable script to get duration for further analysis.

3. RESULT

We mainly focus on two types of intervals: the first one is duration of /a/ preceded by /p/, /t/, /k/, /m/, /n/, /w/, /j/; the second one is that of monosyllables /pa/, /ta/, /ka/, /ma/, /na/, /wa/, /ja/.

Figure 1 illustrates the developmental tendency of /a/ following different types of consonants.

Figure 1: Mean intervals (ms) of /a/ preceded by /p/, /t/, /k/, /m/, /n/, /w/, /j/.

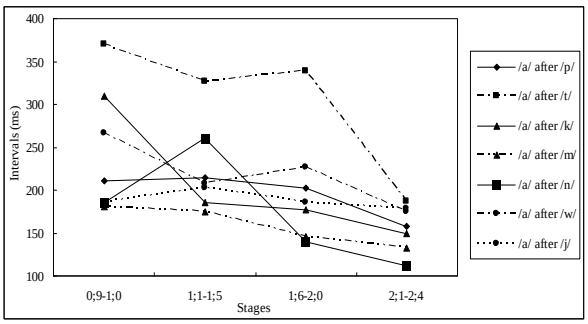

Figure 1 shows that intervals of /a/ tend to decrease as age grows. The decreases in duration for /a/ after /p/, /m/ and /j/ from 0;9-1;0 to 2;1-2;4 are gradual. The mean intervals of /a/ following /p/ are 211, 214, 202 and 158; for /a/ after the nasal /m/, the intervals are 181, 175, 146 and 132 respectively; the durations of /a/ preceded by the approximant /j/ are 185, 202, 186 and 178 from 0;9 to 2;4. But /a/ after the other consonants such as /t/, /n/, /w/ has more fluctuation. /a/ after /k/, for example, has greater decrease from 310 to 185 in the former two periods, while /a/ after /p/, /t/ and /w/ has greater decrease from 202 to 158; 339 to 187; 227 to 175 respectively during the following two stages. This means not all segments are

expected to follow the hypothesis. But segmental duration, on the whole, is on the decrease.

Figure 2: Mean intervals (ms) of monosyllables /pa/, /ta/, /ka/, /ma/, /na/, /wa/, /ja/.

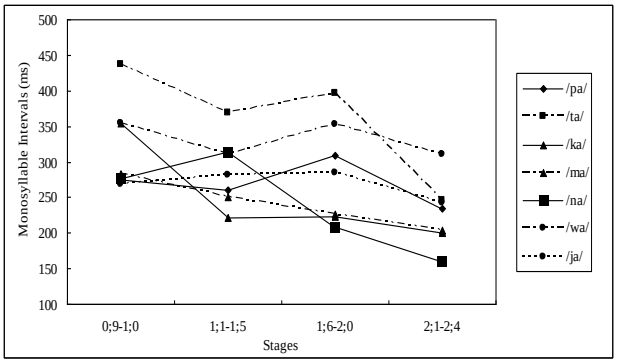

Figure 2 indicates the decreasing tendency of monosyllabic duration with the increased age. The change of duration decrease for /ma/ and /pa/ is steady and gradual from 0;9-1;0 to 2;1-2;4. To put it in detail, the mean intervals of /ma/ are 283, 251, 227, 203 and /pa/ 275, 261, 239, 234. Yet /ka/ has greater decrease from 355 to 221 during the age stage of 0;9-1;5 , /na/ declines from 314 to 208 in the age period of 1;1-2;0, /ta/ has greater decrease from 397 to 245 during the age period of 1;6-2;4. The data indicate that the patterns of duration decrease in segments and syllables prove to be unsystematic.

In order to examine the hypothesis further, we chose /pa/ for further analysis because its production has the highest frequency in both CB and early speech stages.

Figure 3: Mean segmental intervals (ms) of /a/ preceded by /p/ during the age period of 0;10-2;4.

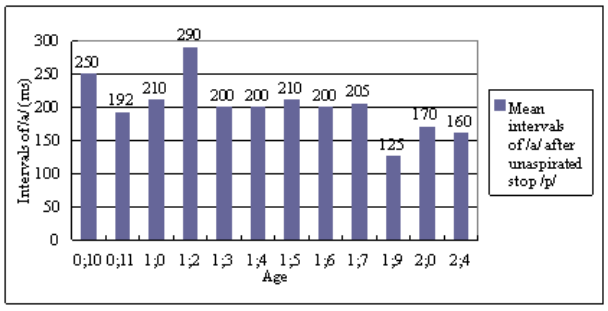

Figure 3 shows that /a/ after /p/ gains greater increase from 0;11 to 1;2, but it decreases drastically from 1;2 to 1;3; from 1;7 to 2;0, the mean intervals fluctuate a lot, while the change of segmental duration across all the other age periods is gradual. Judging from the figure in each age period, there is a general tendency to decrease in segmental duration.

Table 1: Paired sample T-test analysis of intervals of /a/.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	LateBabble1 - EarlyWords1	.027048	.119698	.026120	-.027438	.081533	1.036	23	.313
Pair 2	LateBabble2 - EarlyWords2	.020182	.098590	.029726	-.046052	.086415	.679	13	.513
Pair 3	LateBabble3 - EarlyWords3	-.004417	.069099	.019947	-.048320	.039487	-.221	11	.829

In terms of intervals of /a/ preceded by plosives, nasals and approximants, the Paired samples T-test is used to analyze the tendency. In pair 1, /a/ is preceded by plosives; in pair 2, /a/ is preceded by nasals; and in pair 3, /a/ is preceded by approximants. From the table above, t=1.036, 0.679 and -0.221, Sig values are 0.313, 0.513 and 0.829 respectively. This means that durations of the central /a/ are not statistically significant ($p>0.05$) from late babble and early word stages. Thus, it can be concluded that the change of interval decrease of /a/ is continuous regardless of consonants preceding it.

Table 2: Paired sample T-test analysis of intervals of monosyllabic intervals.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	LateBabble1 - EarlyWords1	.023959	.058911	.012560	-.002160	.050079	1.908	23	.070
Pair 2	LateBabble2 - EarlyWords2	-.00392	.03659	.010563	-.027165	.019331	-.371	13	.718
Pair 3	LateBabble3 - EarlyWords3	.016143	.059135	.015804	-.018000	.050286	1.021	11	.326

Paired samples T-test is used to analyze the tendency of monosyllabic intervals from late babble and early words. In pair 1, monosyllables consist of plosives and /a/; in pair 2, monosyllables are comprised of approximants and /a/; and in pair 3, monosyllables are composed of nasals and /a/.From the table above, t=1.908, 0.371, 1.021, Sig values are 0.070, 0.718 and 0.326 respectively. This means that duration decrease of monosyllables is of no statistical significance ($p>0.05$). Thus, it can be concluded that there is a continuous relationship concerning the change of monosyllabic intervals.

Via the analysis of the SPSS 15.0, $p>0.05$, the decrease of segmental and monosyllabic durations across the four age periods prove to be of no significant difference. It means child decrease of segmental and monosyllabic durations is gradual. It reveals the process of child speech development

which is gradual and cumulative and the stages of language development are continuous.

4. DISCUSSION AND CONCLUSION

Research Question 1: Whether decreases in interval would be greater when children were younger and there would be smaller decreases when older? No, our result is not in support of the above hypothesis. Figure 1 shows that /a/ after such consonants as /t/, /n/, /w/ has more fluctuations. /a/ after /k/ has greater decrease in interval from 0;9 to 1;5, while /a/ after /p/, /t/ and /w/ has greater decrease from 1;6 to 2;4. This means not all segments are expected to follow the patterns predicted in the hypothesis. Figure 2 indicates that the monosyllable /ka/ has greater decrease in interval from 0;9 to 1;5, the great decrease of /na/ is from 1;1 to 2;0, /ta/ has greater decrease from 1;6 to 2;4. The patterns of duration decrease in monosyllables prove to be unsystematic. It is true that there is a tendency of decrease in segmental and monosyllabic duration with the growing age, but the changes are not drastic and abrupt. According to Smith [12], the phonetic changes in terms of duration would go on until as late as 10-12 years of age before reaching adultlike levels. Perhaps that is why there is an unsystematic change of interval in our findings.

Research Question 2: Whether babble drifts in the direction of the speech the child is exposed to and the stages of CB and early speech are continuous or discontinuous? Yes, our findings are in support of the continuity view. Though there is an overall tendency of decreasing in segmental and monosyllabic duration with the growing age, the changes in duration decrease are of no general regularity across all the stages. Via the analysis of the SPSS15.0, the decrease of segmental and monosyllabic durations across the four age periods prove to be of no significant difference ($p>0.05$). It means child decrease of segmental and monosyllabic durations is gradual which has provided acoustic evidence in support of the continuity view in speech development. Babbling stage is a period in which the child speech is shifted in the direction of the language to be learnt, emergence of babble and early speech is greatly influenced by ambient language. Definitely, with the increase of exposure to ambient language, the variation would be smaller and smaller step by step until they attain the adultlike competence.

This study is primarily exploratory in nature. It is based on the utterances produced by one infant. The longitudinal case study of one child is not favorable to the exploration of individual differences, though it is valuable to investigate patterns and sequences of growth and change over a certain period of time. One of the major criticisms of case study research is that a single case does not provide enormous amount of evidence for making generalizations. The findings of the study will need to be extended to larger groups of infants.

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