FUNDAMENTAL FREQUENCY RANGE AND THE DEVELOPMENT OF INTONATION IN A GROUP OF PROFOUNDLY DEAF CHILDREN

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ABSTRACT

Results are presented from a 4-year developmental study of intonation in an unselected group of deaf children educated in an oral environment.

1.INTRODUCTION

Although intonational competence is still developing at 10 years of age in normal children [4], basic patterns are appropriately used by about 3. The speech perceptual and productive abilities of profoundly deaf children are delayed compared with their normally hearing peers [2], but some profoundly deaf children develop good conversational ability and highly acceptable and intelligible speech [3]. Clearly, pragmatic, syntactic, phonetic and phonological features are all important, and, in the area of pronunciation, both segmental and prosodic control have to be achieved.

2. SUBJECTS, TESTS & MEASURES

In this paper we illustrate certain findings relating to intonation development from a 4-year study of aspects of the speech perceptual and productive abilities of a group of 16 severely-profoundly deaf children (from age 7 - 8) educated orally. Results have already been presented for some of the children's intonation after 2 years [1]. Here, we now discuss the fundamental frequency and intonation development of the 2 children with the least impaired hearing and the 2 with the most impaired hearing (according to pure tone audiometry) after 4 years. All four are congenitally deaf. Their pure tone average losses in the better ear at 0.5, 1.0 and 2KHz are

Child 1 - 83dB HL; Child 2 - 90dB HL; Child 15 - 112dB HL; Child 3 - 115dB HL.

Their speech has been recorded at regular intervals and analysed using laryngographic and acoustic techniques. Fundamental frequency measures obtained are compared with qualitative auditory analyses: larynx frequency histograms (Dx plots) derived from recordings made during story telling sessions can be related to perceived pitch range, and modal values related to judgments of perceived high or low voices. Scattergrams (Cx plots) of all pairs of successive vocal fold vibrations in the recording correlate with perceived vocal roughness or smoothness. Figs 1-4 show Dx and Cx plots for Children 1 & 16 in March 1985 and May 1989.

3. RESULTS - QUANTITATIVE

Table 1 shows the frequency ranges and main frequency modes in the children's speech. Second order histograms are used to eliminate creaky voice contribution from the measurements, and the range estimates are from 90% of the digram occurrences. This is our standard procedure in UCL work with deaf adults as well as with children.

Table 1. Fx ranges and modal values

Child	Mode (Hz) of 2nd order range			Range in octaves of 2nd order Dx		
	'85	'87	'89	'85	'87	'89
1.	265	272	225	0.52	0.47	0.44
2.	321	312	157	0.55	0.47	0.53
15.	296	348	312	0.47	0.63	0.36
16.	511	484	304	1.44	0.91	0.51

Note: The 1987 distributions for Children 15 & 16 are multimodal.

4. RESULTS - QUALITATIVE

Apart from Child 15, the other children all show a decrease in modal frequency as one would expect with age, and Child 2's voice has broken in a normal manner. Except for Child 2, the other three still have perceptually high voices.

There is no simple relationship between Fx range measures and perceived narrowness of pitch range and monotonous voice [1]. Apart from Child 16 whose 1985 Fx values represent his physiological rather than his speech pitch range, these 4 deaf children have largely normal octave widths compared with Hunt's normally hearing group [6], but they differ markedly in their control of voice pitch contours to organise their speech in terms of an intonation system.

Over the four years of study (during which time they had no speech-language therapy) the four children show different patterns of intonation development. In 1985 Child 1 was already using pitch to organise her speech into word groups, and using major pitch changes for focus, although most of these nuclear tones were falling and often over-long. Perceptually she had a narrow pitch range. In 1989 nuclear lengthening has disappeared and she is using a full range of nuclear tones in syntactically and attitudinally appropriate ways. Her pitch range no longer seems narrow although the octave width is, in fact, smaller than 4 years earlier. Child 2, similarly, in 1985 showed the demarcative and focussing functions of pitch control but with nuclear lengthening and almost exclusive use of rise-fall tones. (His segmental phonology was much less mature than Child 1's.) He has also made progress by 1989, despite still showing some nuclear lengthening. Most of his tones are falls, but contrast appropriately with rise falls, and some rises are correctly used. With less variety of nuclear tones, his pitch range still sounds narrow. Children 15 and 16 are much more delayed but have made some progress: in 1985 Child 15 had a narrow pitch range but was using pitch for demarcation and focussing. In 1989 his syntax is still very immature but nuclear placement is usually correct. Most tones are falls but rises are beginning to appear. Over the years Child 16, despite his profound hearing loss, has successfully reduced his wide physiological Fx range to one which is speech-like, and has learned to use his vocal output in the give-and-take of conversation; his speech is not very intelligible but is organised in terms of pitch control: he has clear tones, often utterance-final, and nearly always falling. All the children have improved voice quality in terms of regularity of vocal fold vibration.

5. CONCLUSION

There is a dearth of normative data on the pattern of intonation development but these four hearing-impaired children, using conventional amplifying hearing aids from an early age show that even profoundly deaf children can acquire facility with linguistic pitch control in several ways. Nevertheless, their progress is slow and delayed, and it remains to be seen whether gains in phonation quality and in pitch control and use could be obtained at the right moment in development through systematic visual feedback therapy and speech-processing hearing aids that focus attention on the low frequency elements of speech [5].

6. REFERENCES

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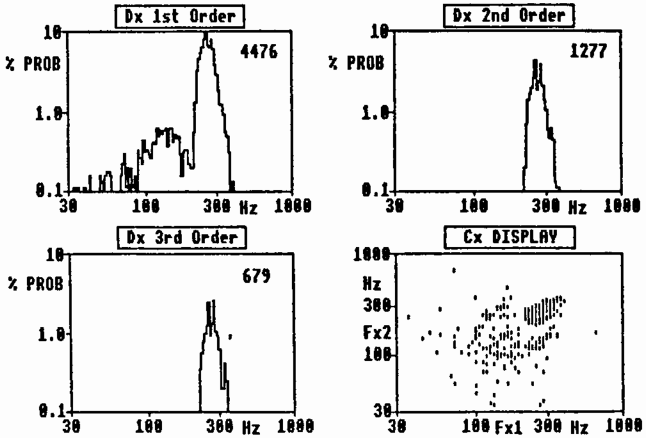

Figure 1 Fundamental Frequency histograms (Dx) and Scattergrams (Cx) for Child 1 in March '85

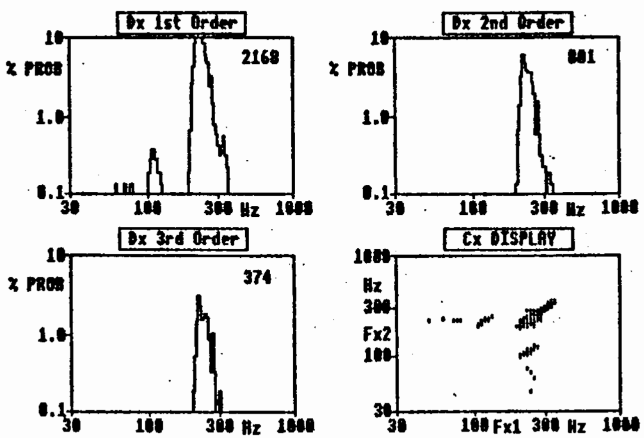

Figure 2 Fundamental Frequency histograms (Dx) and Scattergram (Cx) for Child 1 in May '89 {analyses based on period by period measurements}

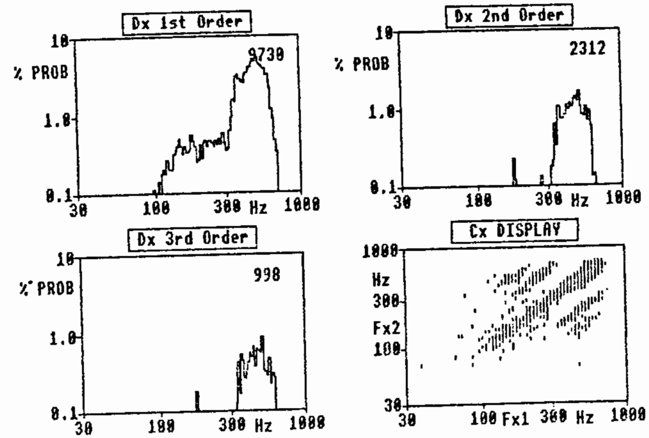

Figure 3 Fundamental Frequency histograms (Dx) and Scattergrams (Cx) for Child 16 in March '85

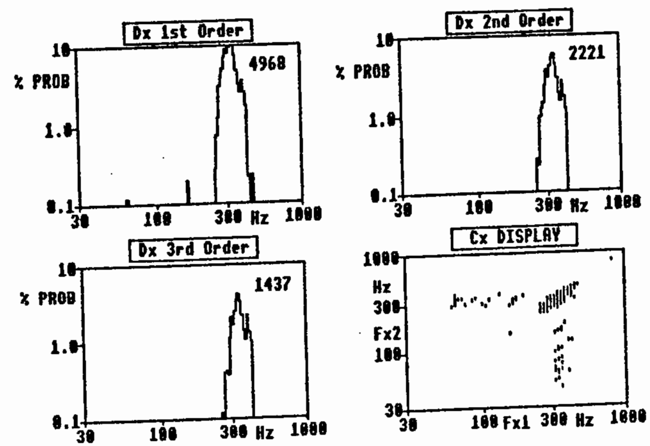

Figure 4 Fundamental Frequency histograms (Dx) and Scattergram (Cx) for Child 16 in May '89 {analyses based on period by period measurements}