Acquisition of the Swedish tonal word accent contrast

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ABSTRACT

Measurements of F0 contours in disyllabic vocalizations show that, at 17 months, Swedish children are beginning to produce contours typical of the grave word accent and to mark the appropriate words with these contours.

1 INTRODUCTION

Studies of phonological acquisition of tone languages frequently state that language-specific features of tone are acquired early; in particular, tonal features are said to be acquired earlier and to show less variability than segmental features (e.g., Chao, 1951; Li and Thompson, 1977; Tuaycharoen, 1977; Tse, 1978; Clumeck, 1980; Crystal, 1986). Proposed explanations have claimed that pitch, the primary auditory correlate of tone, is easy to control in both production (Li & Thompson, 1977) and perception (Tse, 1978). Independent experimental evidence corroborating child phonologists' conclusions that early acquisition of tone has an auditory-motor basis comes from studies showing that infants are able to imitate pitch before the middle of the first year of life (Kessen et al., 1979; Kuhl and Meltzoff, 1988) and discriminate pitch as early as 4 weeks of age (Kuhl and Miller, 1982).

Existing data which might be relevant to tonal development in young children come from small-scale investigations using very small groups of informants and utterance samples. Thus, there is a need to use direct controlled cross-language comparisons to broaden the empirical foundation for further theoretical studies in the area. The general purpose of our current research program is to use large-scale experimental-phonetic techniques, based on cross-language observations, to investigate the development of the Swedish word accent distinction. The present study represents a first step in this direction, focussing on the so called grave accent, which is the marked member of the word accent distinction.

Functionally, the grave accent marks lexical contiguity by connecting a primary stressed syllable with a later secondary stressed syllable. Most disyllabic and polysyllabic words, particularly compounds, have the grave accent. The characteristic F0 correlates of the grave accent in Stockholm Swedish have been shown to include a two-peaked contour resulting from (1) a falling sequence High-Low, associated with the primary stressed syllable, and (2) a subsequent rising sequence Low-High, associated with the secondary stressed syllable (Bruce, 1977; Engstrand, 1989), the latter rise being optional, however, in that it primarily marks sentence stress (Bruce, 1977). The F0 fall has turned out to be an extremely reliable grave accent criterion. In a recent study (Engstrand, 1989), we examined F0 contours correlating with the word accents in spontaneous speech. The results showed that the grave accent was consistently marked by a falling F0 contour in the primary stressed syllable, frequently followed by a rise in the secondary stressed syllable.

It can be concluded for these data that Swedish children are heavily exposed to grave-like pitch patterns, and that it is, therefore, reasonable to expect an influence of this pattern on early imitative vocalizations. The specific purpose of the present study was to investigate: a) whether such an influence is present at the developmental stage where children have a vocabulary of approximately 50 words, i.e. at about 17 months of age, and produce both meaningful and pre-meaningful utterances; and b) whether there is a beginning functional mastery of the system in the sense that children associate grave-like F0 contours with words that have the grave accent in the adult language.

2 METHODS

The question of the presence of grave-like contours in Swedish children's vocalizations was tested by a cross-language comparison, using a comparable group of children acquiring American English. The question of possible functional use of the grave accent was tested by a within-language comparison of grave word candidates as opposed to non-candidates as produced by the Swedish children.

The data were based on audio and video recordings of five monolingual Swedish children and five monolingual American English children. The recordings of the two groups of children were made using the same protocol in the children's homes in Stockholm and Stanford, respectively, biweekly from the age of nine months until the child had an approximate vocabulary of at least 50 words. The results presented here are drawn from that last stage. The data are based on an examination of all disyllabic vocalizations produced by the respective children during one session, i.e., vocalizations that were unambiguously heard as disyllabic by the experimenter, irrespective of whether or not they had been identified as approximations to real words. The material was digitized at 20 kHz. Extracted F0-contours were displayed in synchrony with spectrograms on the computer screen. Vocalizations lacking measurable F0 contours due to voice irregularities were discarded from further analysis. Spectrographic segmentation was made at acoustic discontinuities marking vowel-consonant and consonant-vowel boundaries. F0 values were sampled at the following points in time: a) the acoustic onset of the first spectrographic vowel segment (V1), b) the F0 turning-point, if any, during V1 (if the F0 contour was monotonous throughout V1, the turning-point was assigned the value of the onset), c) the acoustic offset of V1, d) the acoustic onset of V2, and e) maximum F0 during V2 (if F0 declined throughout the V2 segment, maximum F0 was assigned the value of the onset). The Fall parameter was defined as the F0 difference between V1 turning-point and offset, and the Rise parameter was defined as the F0 difference between V2 maximum and V1 offset. Both parameters can thus take positive or negative values; for example, a negative Fall value means that F0 rises in V1, and for a grave-like Fall-Rise sequence, both parameters take positive values.

3 RESULTS

Table 1 shows the mean value in Hz of all measurable utterances for the Fall and Rise parameters for each of the subjects. It is evident that the individual variation is considerable. There is a considerable overlap between the language groups for all parameters. However, an unpaired one-tailed t-test reveals a statistically significant difference between the language group means for the Rise parameter ($df = 8$, $t = 2.31$, $p < 0.05$). There was no statistically significant difference in the Fall parameter.

Table 2 shows the Fall and Rise data a) for the children's grave word approximations, i.e. vocalizations that were judged to represent these children's attempts to say words that have the grave accent in the adult language, and b) for all remaining vocalizations. A paired one-tailed t-test of the difference between the two sets of vocalizations

Table 1. Individual values (Hz) and grand means by ambient language of the Fall and Rise parameters in the complete set of vocalizations.

SWEDISH					AMERICAN ENGLISH				
		$\bar{x}$	s	n			$\bar{x}$	s	n
Didrik	Fall	2	28	99	Emily	Fall	-12	30	43
	Rise	25	27	94		Rise	13	39	31
Hanna	Fall	17	44	76	Deborah	Fall	-14	43	36
	Rise	18	53	76		Rise	26	43	24
Kurt	Fall	-8	28	31	Sean	Fall	8	63	33
	Rise	75	46	31		Rise	8	53	24
Lina	Fall	43	36	63	Molly	Fall	28	29	132
	Rise	52	70	61		Rise	-42	40	132
Stig	Fall	1	32	83	Timmy	Fall	44	41	19
	Rise	51	55	83		Rise	28	43	19
Grand mean	Fall	11	20	5	Grand mean	Fall	11	25	5
	Rise	44	23	5		Rise	7	28	5

Table 2. Values (Hz) of the Fall and Rise parameters in the Swedish grave word candidates and in the remaining vocalizations.

Child	Parameter	Grave word candidates			Remaining vocalizations		
		$\bar{x}$	s	n	$\bar{x}$	s	n
Didrik	Fall	-1	28	42	5	28	57
	Rise	31	29	39	21	24	55
Hanna	Fall	16	45	19	17	45	57
	Rise	25	73	19	15	45	57
Kurt	Fall	-8	28	23	-8	28	8
	Rise	79	48	23	62	40	8
Lina	Fall	39	42	29	47	30	34
	Rise	64	57	27	45	78	34
Stig	Fall	11	27	9	-1	33	74
	Rise	85	40	9	46	72	74
Grand mean	Fall	11	18	5	12	22	5
	Rise	57	27	5	38	19	5

shows a statistically significant difference in the Rise parameter ($df=4$, $t=3.57$, $p<0.05$). Again, there was no statistically significant difference in the Fall parameter.

4 DISCUSSION

In summary, then, an evaluation of the Rise parameter provides evidence that the Swedish children are beginning to produce grave-like F0 contours at 17 months and to mark the appropriate words with these contours. However, the absence of an effect for the Fall parameter, both between language groups and within the Swedish group is unexpected in view of Engstrand's (1989) previous finding that an early F0 fall is an extremely stable feature of grave disyllables in adult-directed speech. It is possible, however, that the Rise and Fall parameter characteristics are different in speech directed to children. In adult to adult speech the rise component of grave F0 contours is known to be sensitive to stress, the height of the rise increasing with the salience of the word. It is conceivable that this becomes more exaggerated in speech directed to children. Phonetic studies of speech directed to children are presently being carried out in our lab to shed light on this question.

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