F₀ contours produced by Swedish and American 24-month-olds: implications for the acquisition of tonal word accents

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Abstract

Previous studies have suggested that most Swedish 17-18-month-olds do not have a productive command of the grave vs. acute tonal word accent contrast. The present paper raises the question whether the accent contrast is more firmly established in Swedish 24-monthers. Auditory observations on 6 Swedish and 6 American English children suggest that a majority of Swedish disyllabic word productions have the two-peaked grave accent, and that accents are usually assigned to words according to the adult norm. Also, the Swedish children produced grave and acute words with F₀ contours synchronized with the segmental tier as expected. Both the grave and the acute contours deviated markedly from those produced by the American English control subjects; in particular, the Swedish contours were more dynamic and reached more extreme values than the American English contours. This is taken to reflect the need to preserve a sufficient contrast between the phonologically distinct word accents. It is tentatively concluded that acquisition of the Swedish word accent contrast typically takes place during the 18-24 months age interval.

1. Introduction

Swedish has a contrast between a ‘grave’ and an ‘acute’ tonal word accent. Whereas the acute accent is associated with a simple, one-peaked F₀ contour, the grave accent is more complex, typically having a two-peaked F₀ contour with a fall on the lexically stressed syllable and a subsequent rise towards a later syllable in the word (Bruce 1977, Engstrand 1995, 1997). Thus, the grave accent can be regarded as a marked feature of disyllabic and polysyllabic words with non-final stress. To a large extent, its occurrence is predictable from morphological structure such that most disyllabic stems and compounds carry the grave accent, whereas some derivations may also be acute. For example, the phrase grön sak [ˈgɾœn ˈsak] ‘green thing’ has an acute accent on each word, whereas the compound grönsak [ˈgɾœnˌsak] ‘vegetable’ carries the grave accent; and the verb stem lånə [ˈlomna] ‘borrow’ is grave, whereas the derivation belånə [ˈbeˌlomna] ‘pawn’ is acute. This predictability suggests that children’s productive command of the accent contrast may depend on a grasp of the relevant morphological operations, which, according to preliminary evidence, may not be developed until around the age of 24 months (Strömqvist et al. 1995). On the other hand, since Swedish children are massively exposed to grave accent patterns, grave-like F₀ contours might be expected to appear at a relatively early stage of development. This assumption has been partly supported by acoustic measurements (Engstrand et al. 1991) and listening tests (Engstrand et al. 2003). These studies suggested that some Swedish 17-18-month-olds are beginning to produce grave-like F₀ patterns in grave word productions as well as in prelinguistic babbling. However, this ambient language effect was rather inconsistent across subjects and vocalizations. In general, then, it could not be concluded that the accent contrast has been acquired by children of that age.

This paper raises the question to what extent the accent contrast has become established in Swedish 24-monthers. We report preliminary F₀ data on disyllabic words produced by a number of Swedish and American English children of that age. The expectations were: 1) that a majority of Swedish word productions carry the grave accent, 2) that accents are assigned to words according to the adult norm, and 3) that words are characterized by appropriately timed F₀ contours similar to those found in adult productions. In contrast, the American English controls were not expected to systematically exhibit grave-like F₀ contours.

2. Methods

Subjects and recordings were described in detail in Engstrand et al. (2003). In summary, recordings were made with each child at two separate, 30-45 minutes long recording sessions separated by an interval of approximately one week. The audio recordings were made using Lavalier microphones and transmitted via FM
All children were accompanied by their mothers during both sessions, except one Swedish girl who was accompanied by her mother during the first session and by her father during the second session. Age-appropriate objects and pictures were used to assist the parents in eliciting word tokens of interest. The parents were representative of the regional standard spoken in the Stockholm and Seattle areas, respectively.

The present study summarizes observations on measurable disyllabic words produced by 6 Swedish and 6 American children during both recording sessions. Only words containing voiced segments were used in this study. In each language group, half of the children were girls and half were boys. According to the methodology used in Engstrand et al. (1991), F0-measurements were made at the following five points in time: 1) the acoustic onset of the first vowel segment, V1, 2) the F0 turning-point, if any, during V1; if the F0 contour was monotonic throughout V2, the turning-point was assigned the value of the onset, 3) the acoustic offset of V1, 4) the acoustic onset of the second vowel segment, V2, and 5) maximum F0 during V2; if F0 declined throughout the V2 segment, maximum F0 was assigned the value of the onset. A Fall parameter was defined as the F0 difference between V1 turning-point and offset, and a Rise parameter was defined as the F0 difference between V2 maximum and V1 offset. Both parameters can take positive or negative values; for example, a negative value of the Fall parameter means that F0 rises in V1; for grave-like Fall-Rise patterns, both parameters take positive values. All measurements were made using the Wavesurfer program package (see reference list).

### 3. Results

Auditory judgments first corroborated the expectation that a majority of the words produced by the Swedish children were convincingly grave-like. However, the proportions differed between individual children, from one child exhibiting only grave-like productions to other children with a somewhat greater proportion of acute words. In general, however, grave and acute accents were assigned in accordance with the adult norm. In contrast, none of the American English word productions sounded convincingly grave.

The measurement results pertaining to the Swedish and American English word productions are summarized in table 1. The upper part of the table presents mean values of the Fall and Rise parameters for individual Swedish and American English children; the number of measurements underlying these means are indicated in the ‘N’ column. The lower part of the table shows grand means, medians and standard deviations pertaining to the respective language groups; these are based on 27 grave and 9 acute productions for the Swedish children and 28 productions for the American English children. ‘F’ and ‘M’ stand for girls and boys, respectively, and the accompanying figures (1-3) identify individual children. For example, the three upper left data cells show that the mean Fall and Rise values for this Swedish girl (F1) are 79 and 66 Hz, respectively, and that these means were based on 4 individual measurements.

The Swedish grave words consistently display positive values for both the Fall and the Rise parameters. This means 1) that F0 declines from a turning-point located somewhere in the primary stress vowel reaching a relatively low value at the end of that vowel segment, and 2) that F0 rises to resume a relatively high position in the second vowel segment. The extent of these F0 movements differ between individual children, but the general pattern is consistent with grand means of 66 and 60 Hz, respectively, and relatively moderate standard deviations.

The Swedish acute productions were few, with two children not producing one single instance. They were, however, rather consistent; again, the Fall parameter values are positive, but smaller than in the grave productions (grand mean 22 Hz). Thus, the acute data, too, suggest a consistent but less prominent F0 decline in the first vowel segment. The Rise parameter values, however, differ sharply – and obviously reliably – from those pertaining to the grave words in that they are consistently negative (grand mean -39 Hz). This means that the F0 descent initiated in the first vowel continues into the second vowel.

F0 values pertaining to the American children tended to resemble those for the Swedish acute productions. Thus, Fall parameter values were moderately positive (grand mean 27 Hz), and the rise parameters tended to be on the negative side (grand mean -6 Hz). Thus, the American data, too, suggest a moderate F0 decline in the first vowel which, on average, continued into the second vowel.
In summary, table 1 suggests that the F0-contours of Swedish grave, Swedish acute and American English words were similar at the beginning, but not at the end of disyllabic words. This appears to indicate that Swedish acute and American English F0 contours differed from Swedish grave contours mainly in lacking the second F0 peak. That this is not the case, however, is shown by the graphic display in figure 1. The graph depicts the grand F0 means pertaining to Swedish grave (filled circles), Swedish acute (unfilled circles) and American English (filled squares, dashed line). The F0 values are time-aligned to the first measurement point. The data points are connected by smoothed lines (that bear a certain resemblance to authentic F0 contours).

First note that the timing of F0 events differs between the Swedish grave and acute accents. In particular, the initial F0 peak appears early in the grave contour such that most of the stressed vowel segment is occupied by the fall. In contrast, the acute F0 peak appears well after the middle of the corresponding vowel segment with the fall occupying just a small portion of the vowel. Thus, the acute F0 contour differs from the grave contour both in having a late turning-point in the first vowel and in lacking a secondary peak in the following vowel.

The American English F0 contour bears a greater resemblance to the acute than to the Swedish grave contour, as noted above. Thus, the initial F0 peak appears relatively late in the first vowel segment such that the subsequent fall occupies approximately half of the vowel. Thus, the American English F0-contours, too, differ from the Swedish grave contour both in having a late turning-point in the first vowel and in lacking a secondary peak in the following vowel. On the whole, however, the American English contour is less dynamic and reaches less extreme values than the Swedish F0-contours.

![Figure 1. Average F0 contours derived from mean parameter values shown in table 1. Filled circles: Swedish grave, unfilled circles: Swedish acute, filled squares, dashed line: American English.](image-url)
4. Conclusions
Auditory judgments have supported the hypothesis that disyllabic words produced by Swedish 24-months-olds mainly carry the grave tonal word accent. This is an expected influence of the ambient language, since a majority of disyllabic Swedish words are characterized by that accent. Even though the grave accent tends to be somewhat over-generalized, the few instances of acute words were produced in accordance with the adult norm. This suggests that many Swedish children at 24 months of age are in a fair way to establishing a productive command of the word accent contrast.

It is also clear that the Swedish 24-monthers produced grave and acute words with the expected F0-contours, and that the turning-points of these contours were, furthermore, synchronized with the segmental tier according to the adult norm. These contours deviated from those exhibited by the American English controls; in particular, they were more dynamic and reached more extreme values than the American English contours. This appears to reflect the need to preserve a sufficient contrast between the two phonologically distinct accents.

Against the background of the less mature F0 patterns previously found in 17-18-monthers’ vocalizations (Engstrand et al. 1991), these observations suggest that acquisition of the Swedish tonal word accents typically takes place in the 18-24 months age interval. However, the validity of these preliminary conclusions will have to be judged on the basis of a more substantial database.

References
Wavesurfer, http://www.speech.kth.se/wavesurfer/