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Vowels in infant- and adult-directed speech

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Abstract

F1 and F2 frequencies of the vowels /i/, /a/ and /u/ were measured in speech directed to an infant and to adults. The vowels were taken from content words as well as function words. The results showed that the vowel triangles in speech to the infant were expanded compared to those in speech to adults, but only in the content words. For function words, the opposite pattern was found: adults produced more expanded vowels in adult-directed speech than in infant-directed speech.

1 Introduction

Children have to learn which the speech sounds are that constitute the phonetic system of their native language. One major problem in this is that the acoustic realization of speech sounds is highly variable, depending, for instance, on the identity of the speaker, his or her dialect, or the phonetic context. Recent evidence, however, has suggested that the acoustic structure of the speech that adults address to children can facilitate the acquisition of the sound system of a language.

The evidence comes from a study by Kuhl et al. (1997) who found that the vowel space in infant-directed speech (IDS) was expanded compared to the one in adult-directed speech (ADS). The researchers demonstrated that the F1 and F2 frequencies of the three point vowels /i/, /a/ and /u/ in IDS were further away from the center of the vowel space than those in the ADS. The analyzed vowels were taken from preselected content words, and were recorded while mothers interacted with their child, and, subsequently, during informal interviews with the experiment leaders. This result suggests that adults adopt their speech, by making the perceptual contrasts between the individual segments bigger, which, most likely, facilitates the child's acquisition of the phonological system.

The question addressed in the present study is whether the results reported by Kuhl et al. (1997) can also be applied to function words. Although there are only few function word types, a large part of everyday speech, probably even a majority, consists of function word tokens (Cutler 1993). In other words, a great part of the vowels that infants actually hear are produced in function words, and not in content words.

In order to address this question, I compared the F1 and F2 frequencies from the vowels /i/, /a/ and /u/ that adults produced in content words as well as function words. The material used for the present study consists of a sample of naturalistic IDS and ADS.

2 Methodology

The material used for the present study was selected from an existing data set which is described in my dissertation (van de Weijer 1998). This data set consists of almost all the speech that one infant heard during 18 days selected from the first, middle, and last week in the period when she was between six and nine months old.

Table 1. Examples of function and content words that were used in the analysis.

	/i/			/a/			/u/		
<i>content words</i>	zie	/zi/	<i>see</i>	klaar	/klar/	<i>ready</i>	goed	/xut/	<i>good</i>
	drie	/dri/	<i>three</i>	staan	/stan/	<i>stand</i>	hoest	/hust/	<i>cough</i>
	vies	/vis/	<i>dirty</i>	laat	/lat/	<i>late</i>	doen	/dun/	<i>do</i>
<i>function words</i>	niet	/nit/	<i>not</i>	maar	/mar/	<i>but</i>	moet	/mut/	<i>must</i>
	die	/di/	<i>that</i>	laat	/lat/	<i>let</i>	hoe	/hu/	<i>how</i>
	wie	/vi/	<i>who</i>	waar	/var/	<i>where</i>	toen	/tun/	<i>then</i>

During these 18 days, the infant heard speech that adults addressed to her, but also speech that adults addressed to each other. Most of that speech was produced by not more than three speakers whose utterances are used for the present study: the father, the mother, and a babysitter.

The data were collected in the Netherlands, and, consequently, the language that was spoken was Dutch. However, the mother was originally from Germany, and addressed her children in German as well as in Dutch. Since she always spoke Dutch to other adults, no German words are included in the analysis.

The choice of the words was determined by the available material, so that a variety of function words and content words were used. All words were monosyllabic, and had a consonantal onset. Some examples are listed in Table 1. The total number of content word types was 67, and the total number of function words types was 19.

A waveform and a spectrogram of the utterances in which the words occurred were displayed on the screen of the computer. The vowels were subsequently cut out of the words, and a new spectrogram of the vowel with an overlay of the formant tracks was created automatically by the computer. The center frequencies of F1, F2 and F0 were then stored in a data file. All measurements were done with the speech-analysis program PRAAT, developed at the University of Amsterdam by Paul Boersma and David Weenink. The area of the space between the three vowels (vowel triangle) was subsequently calculated automatically in an Excel worksheet.

3 Results

A total of 593 vowels were measured: 260 content words, and 333 function words. Not always did the speech editor find a formant or F0 frequency. As expected, all speakers had higher average F0 when they addressed the infant than when they addressed other adults.

The main results of the F1 and F2 measurements are represented in Figure 1. This figure shows the F1 and F2 frequencies of the vowels averaged per speaker, word class, and addressee. In IDS as well as in ADS, the vowel triangles of content words were bigger than those of function words.

More interestingly, when IDS is compared with ADS, the results showed a different pattern for content words than for function words. For two of the three speakers (the father and the babysitter), the vowel triangle of content words was bigger in IDS than in ADS. For the mother, it was slightly bigger in the ADS, but this difference was only very small. So far, the results correspond largely with those of Kuhl et al. (1997). On the contrary, for all three speakers, the areas of the vowel triangles of function words were bigger in their ADS than IDS. In other words, the adults pronounced vowels in function words more clearly when they spoke with other adults than when they spoke to the infant.

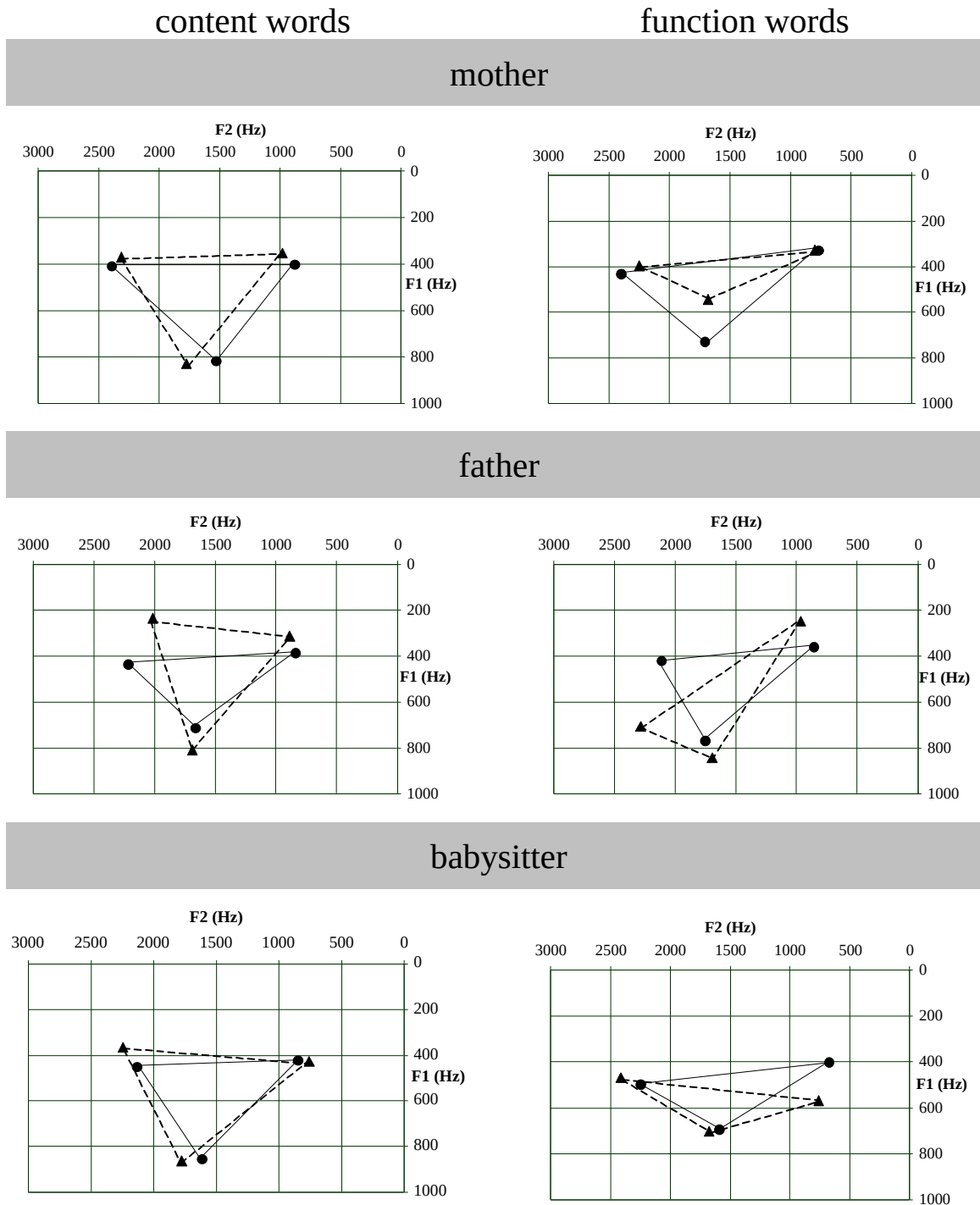


Figure 1. The three diagrams to the left represent the content words, those to the right are the function words. The graphs indicate average F1 and F2 frequencies of /i/, /a/ and /u/ in IDS (triangles) and ADS (circles). The vowel triangles are drawn as dashed lines for IDS, and as solid lines for ADS.

4 Discussion

The results of previous research on the acoustic structure of vowels suggested that adults articulate vowels more clearly when addressing infants than when addressing other adults. The results of the present study suggest that we have to be careful with the interpretation of this conclusion.

First of all, not all speakers in the present study showed an expansion of the vowel triangle of content words in IDS. The vowel triangle of the mother was actually a little bit bigger when she addressed adults than when she addressed her daughter. Second, the pattern of results which applied to content words did not apply to function words. All the adults produced vowels in function words more clearly when they addressed other adults than when they addressed the infant. The pattern for function words is, in other words, the opposite from content words. Note, however, that the vowel triangles in the adult-directed function words were not bigger than those in the infant-directed content words.

Function words make up a relatively big proportion of our everyday speech. Therefore, it seems that at least a considerable part of all the vowels that infants hear are acoustically 'poorly' specified.

How can the two opposite patterns of results be explained? Possibly, adults put extra effort in pronouncing content words more clearly when addressing infants, and this extra effort goes at the cost of function words which become reduced. This is not a very likely explanation however. A second explanation relates to the importance of function words in ADS compared to IDS. In ADS, sentences are generally longer, and grammatically more complex. The meaning of the sentence depends, consequently, more heavily on the function words than is the case in IDS. Accordingly, function words are pronounced more clearly in ADS.

Which, if any, of these explanations is the right one, I cannot answer at present. More information on acoustic characteristics of speech sounds in language addressed to infants is needed.

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