Changes in IDS and ADS during parental leave – project sketch and first results of pilot study

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Abstract
We are investigating the speech of German and Swedish mothers and fathers during the first year of their first baby. Both infant- and adult-directed speech are analyzed and compared between the sexes but also between different time points during the first year. In addition, the involvement in child care is considered as a potential factor. We are now in the process of finding participants and gathering data (read speech and spontaneous speech) from the first recording before birth of the child. Here, the speech material, our hypotheses and first pilot studies are presented.

keywords: IDS, ADS, sex-specific differences

1. Introduction
There is a growing body of evidence from articulatory and acoustic studies indicating that females speak more clearly than males (e.g. [1, 2, 3, 4, 5]) However, it still remains a matter of speculation as to why this might be the case. In particular, sociolinguistics has suggested that female speakers, often primary caregivers and guardians of the mother tongue, may seek to produce a clearer speaking style [6]. To our knowledge, this has never been empirically tested. In this project we investigate possible predictions arising from this assumption:

1) Male and female speakers produce clearer speech forms during their time as caregivers.
2) The clearer speech forms are not only restricted to infant-directed speech (IDS) but are also a feature of adult-directed speech (ADS)

While there has been a good deal of studies on female IDS (motherese), also comparing it to female ADS (e.g. [7, 8, 9, 10, 11]), similar studies on male subjects are few and far between (but see [12]). Recent socio-political developments in Germany and particularly in Sweden have made it possible to systematically investigate not only the speech of mothers but also of fathers in the role of primary caregiver.

The analysis is oriented on findings regarding sex-specific differences and characteristics of IDS. Both IDS and female speech differ from ADS and male speech, respectively, in temporal patterns and spectral characteristics (for an overview see e.g. [13], [14]). The project comprises the investigation of speech tempo, segment durations, average f0, f0 range, vowel space and sibilant contrast realizations. The speech material consists of a reading task and a picture naming task. The practicability of elicitation methods and recording procedures have been tested in two pilot studies.

[15] compared f0 and vowel space dimensions in IDS and ADS of seven male fathers. A larger vowel space in IDS than in ADS was found only in the reading task, not in the picture task. A higher average f0 and f0 range (SD) in IDS than in ADS was found with a stronger effect in the picture than in the reading task (see Figure 1).

Figure 1: Polygon size of F1/F2 space measured in /iː/ and f0 variation (SD of average f0) of 7 fathers during ADS and IDS in reading and picture naming task

In a further pilot study IDS and ADS of a single male subject before and after a two-month period of parental leave were investigated. A larger vowel space was found in IDS after the birth of the child, but only before parental leave, with a stronger effect in the reading task. After parental leave the ADS vowel space was found to be enlarged by comparison with its size before parental leave. Both average f0 and f0 range (SD) were greater in IDS than ADS before parental leave, with a stronger effect in reading task. After parental leave we find both a greater average f0 and f0 range in ADS by comparison with the recording before parental leave.

Figure 2: Polygon size of a father in reading (left) and naming task (right) during ADS (red) and IDS (blue) at two time points (before parental leave and after)
2. Project sketch

The project investigates the potential relationship between typical phonetic correlates of careful speech and gender-specific roles - here, in the function of a primary caregiver of an infant. The focus of the study is not solely on infant-directed speech, but in particular the potential impact of being the primary caregiver on adult-directed speech. The project involves two different locations in Europe: Jena, Germany and Stockholm, Sweden. Sweden is particularly interesting due to its leading position in gender equality and the compatibility of family and work in Europe since the 1970s. Thus, the ongoing change of the conventional gender roles will be reflected in this project and cross-cultural and cross-linguistic analyses can be made.

We investigate both IDS and ADS speech samples of mothers and fathers at four time points during the first year of the child: 1) before birth, 2) and 3) during parental leave and 4) one month after parental leave is finished (see Fig. 3). The age of the infant at the time of recordings has to be comparable between different participants. Thus, the second and third recording will take place when the infant is between 5 and 7 and between 8 and 10 months old. These time periods were chosen since it is possible to find fathers who stay at home while the mothers are working only from around month six.

We aim at gathering data from 15 mothers and 15 fathers in parental leave, and 10 working fathers as a control group. We are still in the process of finding participants but until now we have collected German data of the first recording session from 10 mothers (Mo), 2 fathers (Fa) and 9 control fathers (CFa).

The speech material consists of read speech and a picture naming task. The read speech comprises seven modified extracts from Astrid Lindgren stories [16], chosen because they are also very well known in a German context. The texts were modified to contain multiple tokens of peripheral vowel qualities and sibilants. The target sounds are embedded in the names of the children who are repeated frequently in every short story. Samples of spontaneous speech are elicited from a naming task using 15 pictures of animals and objects. Figure 2 shows some of the pictures used to elicit target words containing the vowels \( /i, e, a, u/ \) and sibilants \( /s, f/ \) (e.g. Kuh, Katze, Tiger; Tasse, Tasche). The target objects were also chosen because they are suitable for eliciting vowels in both German and Swedish (e.g. ko, kat, tiger; mössa, körsbär).

Each participant sees each text only once, and the order of the task (reading, picture naming) is randomized over the sessions. Also, the order of speech register (ADS vs. IDS) is randomized for each speaker in each recording session. The interlocutor for the ADS register is always the same (a female student assistant) in each language.

Additional information about the participants is gathered at the different recording sessions by means of several questionnaires. Two important factors are: 1) the general involvement in care-giving and 2) the amount of speech used with the child. The answers to the questions result in numbers for the two factors that can be correlated with parameters in the acoustic analysis.

Socio-psychological information regarding self-reported assessment of masculinity/femininity (TMF, [17]) is also collected together with data on the positive attributes more socially desirable for women (e.g. emotional, helpful) using the GEPAQ-F scale [18].

2.1. Hypotheses

The project seeks to test two general hypotheses:

a) A change is found towards an enhancement of speech clarity in IDS in fathers (and mothers), and it is affected by the duration of parental leave and the involvement in child care.
One question is whether the amount of involvement in child care by the father correlates with the typical parameters of IDS. Related to this is whether the general involvement in care-giving is less important than the amount of speech used with the child (through singing, reading and talking).

b) A change is found in the fathers’ phonetic correlates of clear speech also in ADS resulting in a decrease in sex-specific differences, during, or even after parental leave. We will consider this against the backdrop of the socio-psychological attributes (TMF, GEPAQ-F).

### 3. First results

Due to the early state of the project, we will concentrate on data from three German speakers, who are representatives of the three different speaker groups that we are investigating: 1) mothers on parental leave (Mo), 2) fathers on parental leave (Fa) and 3) working “control” fathers (CFa). Until now, we only have data from the first recording (before the birth of the child). We will focus on the initial measurements taken in the read speech and the picture naming task in ADS.

Table 1: Average f0 and SD of three speakers for the two tasks

<table>
<thead>
<tr>
<th>speaker</th>
<th>speech material</th>
<th>f0 (hz)</th>
<th>sd (hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mo01</td>
<td>pic</td>
<td>227.4</td>
<td>37.64</td>
</tr>
<tr>
<td></td>
<td>read</td>
<td>223.91</td>
<td>36.95</td>
</tr>
<tr>
<td>CFa02</td>
<td>pic</td>
<td>98.43</td>
<td>28.09</td>
</tr>
<tr>
<td></td>
<td>read</td>
<td>98.6</td>
<td>28.69</td>
</tr>
<tr>
<td>Fa01</td>
<td>pic</td>
<td>131.44</td>
<td>32.3</td>
</tr>
<tr>
<td></td>
<td>read</td>
<td>146.15</td>
<td>36.25</td>
</tr>
</tbody>
</table>

Table 1 shows the average f0 and the standard deviation of f0 for the three speakers. While Mo01 and CFa02 show expected values of 225 Hz for the female and 98 Hz for the male, Fa02 reveals a higher mean f0 than expected from the average value of a male speaker.

The two main spectral analysis parameters are 1) the size and dimensions of the vowel space and 2) the sibilant contrast realization. Figure 2 shows the vowel space spanned by F1 and F2 (in Hz) separated by speech material and speaker. The control father reveals the smallest vowel space, while the mother - as expected - has the largest vowel space. Interestingly the father that plans to stay at home and take care of the child for some months lies between the two. Differences between the speech tasks are speaker-specific: CFa02 exhibits a larger space in the picture naming task, Mo01 a larger space in the reading task and Fa01 does not differ much at all. To quantify the dimensions of the vowel space Table 2 shows the EDs in the horizontal and vertical dimension (ia and iu).

Table 2: EDs between /a/ and /ɛ/ and between /ɛ/ and /a/

<table>
<thead>
<tr>
<th>speaker</th>
<th>speech material</th>
<th>ED_ia (hz)</th>
<th>ED_iu (hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mo01</td>
<td>pic</td>
<td>989</td>
<td>1580</td>
</tr>
<tr>
<td></td>
<td>read</td>
<td>1206</td>
<td>1828</td>
</tr>
<tr>
<td>CFa02</td>
<td>pic</td>
<td>722</td>
<td>1444</td>
</tr>
<tr>
<td></td>
<td>read</td>
<td>529</td>
<td>1226</td>
</tr>
<tr>
<td>Fa01</td>
<td>pic</td>
<td>958</td>
<td>1122</td>
</tr>
<tr>
<td></td>
<td>read</td>
<td>904</td>
<td>973</td>
</tr>
</tbody>
</table>

For the acoustic parameterization of the sibilants, the spectral moments following [19] are measured but also Discrete Cosine Transformation (DCT; [20]) is used. The spectral moments consist of 1) the centroid frequency or Center of Gravity (COG), 2) the Standard Deviation (SD) of the COG, 3) the skewness describing the energy distribution over the whole frequency range of the spectrum and expresses if the frequencies are skewed towards the higher or the lower frequencies; and 4) kurtosis which reveals the spectral peakedness of the distribution. Recently, DCT has been shown to distinguish sibilants very well ([21, 22, 23, 24]). DCT decomposes the signal into a set of half-cycle cosine waves whereby the resulting amplitudes of these cosine waves are the DCT coefficients. We will concentrate on three DCT coefficients, which 1) are proportional to the linear slope of the spectrum (DCT1), 2) correspond to its curvature (DCT2), and 3) describe the amplitude of the higher frequencies (DCT3). Figure 6 shows DCT3 plotted as a function of DCT1 separated by speaker, reading task and sibilant. A difference in acoustic contrast can be seen between the speech tasks, with a
clearer contrast in the read speech. Regarding sex-specific differences, a clearer contrast in the female speaker (Mo01) was expected, but is only apparent in comparison to one of the two male speakers (i.e. Cfα01).

Figure 6: Acoustic contrast of sibilants measured in DCT1xDCT3 space

To quantify the sibilant contrast, the Euclidian distance between the sibilants in DCT1xDCT2xDCT3 space was calculated for each speaker and speech task. The male speaker, Cfα01, and the female speaker, Mo01, exhibit contrasts as expected: in the picture task the male’s ED is nearly half of the female’s ED (5.1 vs. 9.1). In the reading task the contrast is enhanced for both but much more so for the male (m: 10.9 vs. f: 11.3). The second male speaker (Fa01) again exhibits an unexpected pattern (as for f0 and vowel space size): he has the highest contrast in both speech tasks (11.6 and 12.6).

4. Conclusion

Two small pilot studies together with the results of the initial recordings in the main study have proven the practicability of the elicitation methods and recording procedures. The acquisition of further data, especially at different time points, will show whether the initial findings showing the expected tendencies can be substantiated, i.e. with the group of fathers on parental leave having f0, vowel space values and sibilant contrasts between those of the mothers and the working “control” fathers.

5. Acknowledgements

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6. References