

Changes in parents' phonetic parameters during the first year of a child's life. Comparative study of German and Swedish

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ABSTRACT

This paper deals with inter- and intra-speaker variation over time in adult-directed speech of first-time parents. The study investigates the potential effects of sociopsychological parameters such as parental involvement and gender identity in German and Swedish mothers and fathers.

Picture descriptions of 71 participants were recorded at four time points (one before the birth of the child, three more during the baby's first year) and acoustic analyses were conducted regarding mean fundamental frequency and acoustic vowel space.

Inter-speaker variation was found between the parental groups reflecting (culture-specific) gender roles (expressed through parental involvement and femininity). Intra-speaker variation over time in mean f_0 only found in the German mothers, points to the role of sociopsychological factors besides hormonal influences due to pregnancy.

Keywords: fine phonetic detail, f_0 , AVS, parents, intra-speaker variation

1. INTRODUCTION

Until recently, sex- and gender-specific fine phonetic detail has been investigated by highlighting differences between male and female speakers. Alongside biological factors responsible for differences between the sexes [1-4], social factors have been claimed to explain gender-specific variation in adults [5-9]. By looking at variation within genders and incorporating the impact of sexual orientation, gender research has become increasingly multi-faceted [10-12].

Most recently, gender identity in terms of self-rated femininity, masculinity or gender role orientation has become a further intriguing factor being considered to explain gender-specific variation in fine phonetic detail within females and males independently of or in addition to sexual orientation. Heterosexual German males have been found to indicate self-ascribed femininity through fine phonetic detail [13]. The study found that the more feminine a speaker rated himself, the higher his speaking fundamental frequency (SFF) and the larger his acoustic

vowel space (AVS) – i.e. these males exhibited phonetic parameters shifted towards female values. In addition, [14] showed that gender identity differs between German and Swedish participants with Swedish females showing lower femininity scores than German females, in turn resulting in similar scores between the genders in Sweden, but significant differences in Germany.

The present study also looks at the relationship between gender identity and phonetic cues in German and Swedish speakers, but additionally investigates the gender role, more specifically differences in parental role of individual speakers. Moreover, intra-individual variation is examined in self-ascribed gender identity in young parents during the first year of their first child's life – looking at possible changes in fine phonetic detail. [16] found lower SFF and less variation in SFF in English females one year after giving birth than during pregnancy and 5 years later. The authors name several potential reasons for these intra-individual changes over time. The main factor the authors suggest are hormonal changes after pregnancy (decrease in estrogen). However, they also point to the potential influence of behavioral factors such as mental and physical fatigue. A similar decrease in SFF and AVS has also been found in German mothers during the first year after the birth of their first child [15], accompanied by changes in self-ascribed femininity. The present study adds a later time point for the German data set as well as comparing the German speakers with Swedish mothers and fathers from speech samples recorded at the same four time points before and after the birth of the first child. Sociopsychological data (self-ascribed femininity and parental involvement) are collected and investigated as possible interacting factors.

2. METHOD

Written consent from all subjects taking part in the study was obtained prior to the recording. The project of which this study is part (see [15]) was reviewed and approved by the ethics committee of the University of Jena. Acoustic recordings and sociopsychological data (regarding femininity and parental involvement) were collected from Swedish and German mothers and fathers at four time points before the baby's birth and within its first year.

2.1. Participants and sociopsychological measures

35 Swedish speakers (15 females and 20 males) and 36 German speakers (15 females, 21 males) participated in the study. The German participants were on average 29.6 years ($SD = 3.7$, mothers) and 30.8 years ($SD = 6.0$, fathers), respectively. Swedish participants were on average 31.5 years ($SD=3.9$, mothers) and 32.8 years ($SD=4.5$, fathers), respectively. The fathers differed in the time they stayed at home with the child as primary caregiver and were separated into 2 groups, accordingly. One group (Fa) consisted of fathers who took parental leave for at least 3 months when their child was between three and ten months old, this being the crucial period when recordings two and three were made. The other (control) group comprised fathers (CF) who, on average, only took 12 days (Sweden) or 10 days (Germany) leave. In Sweden 6 males from the Fa group, while in Germany 9 Fa males took part. The CF group is represented by 11 German and 15 Swedish participants.

Participants were asked at each time point about the time they spend with their child and the activities they do with them (eight items, asking about the frequency of doing things like play, comforting, nappy changing in comparison to their partner). Figure 1 shows the values averaged over the three time points within the first year separated by group and country. A split between the groups, with Fa participants lying between CF and Mo, is apparent in both countries. However, it is more distinct in the German group. The LMM with involvement as dependent variable and speaker as random effect reflects this by showing a significant interaction of country and speaker group ($\chi^2(3) = 23.5$, $p < .001$). Post hoc comparisons reveal significant differences between all three groups in the German participants ($p < .05$), but only between Mo and CF in the Swedish participants ($p < .001$). In the Swedish sample, the less clear separation between the father groups and the genders in general points to a more balanced participation in childcare.

Regarding gender identity, data was gathered in terms of self-ascribed femininity using the GEPAQ_F+ questionnaire (positive Femininity scale of the German Extended Personality Attributes Questionnaire [17]). The questionnaire consists of 8 bipolar adjective pairs describing positively evaluated personality traits traditionally attributed to women (such as kind, empathetic, sensitive, gentle). The German version was translated into Swedish. Participants were asked to rate themselves on these adjective pairs on a scale from 1 to 7. Mean values were calculated for each participant with high values reflecting a high femininity score.

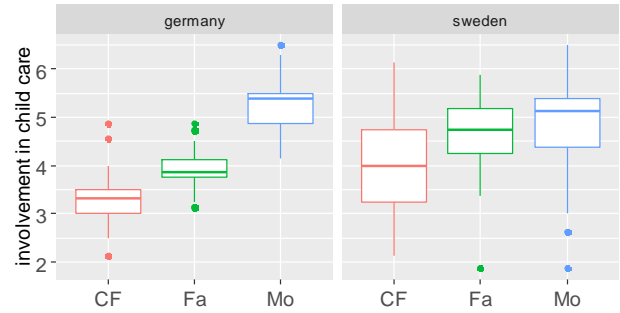


Figure 1: Involvement in childcare separated by country and parent group. High values reflect a strong involvement in childcare.

2.2. Speech data collection

Acoustic recordings were conducted using a headset-microphone (Sennheiser ew 100 G3 – SK100) and a ZOOM – H6 Handy Recorder. Each speaker was recorded at four different time points at their homes by a German or Swedish female experimenter, respectively. The first recording took place 4 weeks before the expected due date. The second recording was conducted approximately 5 months, the third one 8 months and the last one 12 months after the birth.

Semi-spontaneous speech material was elicited using a picture description task. Participants were asked to describe the same fifteen pictures (in a randomized order) at each of the four recording sessions to the experimenter. The pictures showed various objects and animals that were chosen as carrier words for the selected target vowels, with each carrier word appearing on at least three pictures (see [14]). Vowels slightly differ between the languages due to language specific vowel inventories. The respective vowels (for German: /i: ε a u:/, for Swedish: /i: ε a u:/) were chosen to estimate the vowel space area (VSA) by calculating the area of the polygon formed by joining the points defined by the first two formants of these vowels. In total, 5446 vowel tokens were analysed for the Swedish data set and 4839 vowel tokens for the German data.

2.3 Acoustic analysis

Acoustic analyses were carried out in PRAAT [18]. Modified versions of publicly available scripts - distributed under the GNU General Public License by Mietta Lennes and Jonas Lindh - were used to calculate the respective phonetic parameters. A psychoacoustic transformation of formant and fundamental frequency values from Hz to Bark was carried out [19]. The calculation of the AVS was done using the phonR package [20] in R [21].

2.3.1 Speaking fundamental frequency (SFF)

SFF was measured for each participant and time point over the whole sequence of the spontaneous data recorded during the picture description task. Recordings lasted on average 223 seconds (SD=167 s) in the German data, and 287 seconds (SD:178 s) in the Swedish data. The analysis parameters in PRAAT consisted of a minimum pitch of 75 Hz, a maximum pitch of 600 Hz and a time step of 0.01 s.

2.3.2 Formants and acoustic vowel space (AVS)

The first two formants (F1, F2) in the target vowels of the carrier words were measured at the vowel midpoint. The analysis parameters consisted of a time step of 0.01s, the maximum number of formants = 5, a window length of 0.025 s and a pre-emphasis from 50 Hz. The maximum formant value was set to 5000 Hz for males and 5500 Hz for females. Measurements were checked manually if necessary. Mean F1 and F2 values of each vowel category were calculated for each speaker and time point and used to estimate the size of a speaker's AVS for each recording.

3. RESULTS

Prior to statistical analysis we begin by providing a description of certain general patterns that are apparent from Fig. 2. This allows us to consider similar developments in the different parameters (femininity, SFF, AVS) over time, as well as possible similarities in the differences between the parental groups (CF, Fa, Mo) across the different parameters. In the statistical analysis, on the other hand, we will be concentrating on individual parameters separately as they differ between the groups and across the time points.

3.1 Variation patterns in femininity and phonetic parameters over time – descriptive analysis

Figure 2 shows the variation in self-ascribed femininity (top), SFF (middle) and AVS (bottom) over the child's first year for the different parent groups.

Independent of time, the figure shows interesting differences between parent groups and countries. As already shown in [14], regarding femininity, the genders only differ in Germany but not in Sweden, which is reflected in smaller phonetic gender differences in Sweden than in Germany. In addition, we can see that while the German CF and Fa groups vary with higher values for Fa and thereby more towards the femininity scores of the mothers, the Swedish Fa group lies below the CFs – except for the time following the baby's birth (2, green in Figure 2). Regarding the phonetic parameters (middle and bottom panels), patterns

similar to the femininity scores arise: while the German Fa parents lie in between CF and Mo (analogue to their femininity score), the Swedish Fa parents pattern with the CF males (for AVS) or show values below them (for SFF) – reflecting their somewhat lower femininity score.

Looking at the variation over time, the clearest pattern can be seen in the German Mos, with decreasing values in all three parameters (femininity, SFF and AVS) from time 1 to 3 and a slight increase again to time 4 (c.f.[15]). However, for the other groups the patterns are not as apparent. The Swedish Fa group also shows time-dependent variation in femininity with highest values at time 2 after the birth of the child (as mentioned above). However, this is not reflected in the phonetic parameters. In the Swedish mothers a similar pattern appears in femininity and AVS but not SFF.

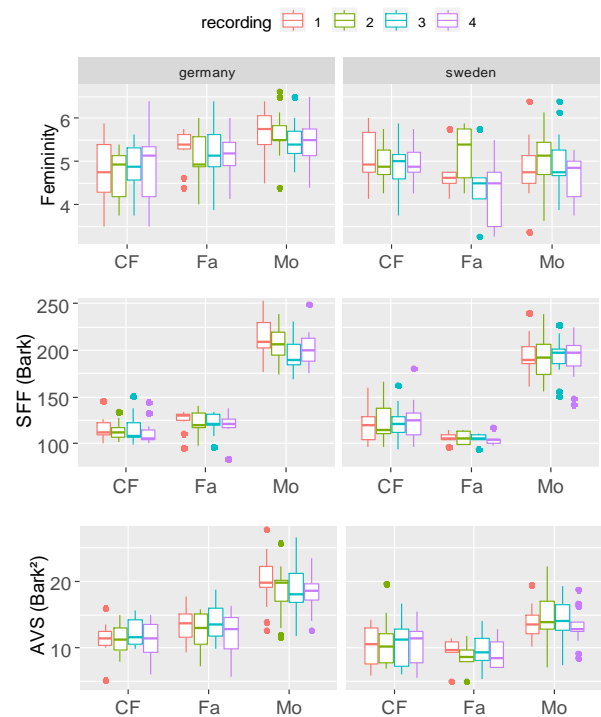


Figure 2: Femininity (top), SFF (middle) and AVS (bottom) separated by time of recording, country and parent group.

3.2 Statistical analysis

Statistical analyses were conducted in R [20]. Linear mixed models were run using *lme4* [22]. P-values were obtained using Likelihood ratio tests comparing models with and without factors in question. Post hoc Tukey tests were calculated using *lsmeans* [23]. As fixed effects we entered parent group, time and country, and speaker as random effect.

Since in [13] significant positive correlations between femininity and SFF and AVS were found for German male participants at the first time point, here, we investigated this relationship for this time point in the

Swedish participants. In contrast to the German data, no significant correlations were found, either for males or females.

Regarding femininity, a significant interaction of group and country ($\chi^2(4) = 19.46, p < .01$) was found. Post hoc tests reveal only the difference between the German CF and Mo speakers to be significant (estimate: 0.79, $p < .001$). The three-way interaction of group, country and time fails to reach significance ($p = .09$), which is probably due to the high intra-group variation for each of the time points.

For SFF, the three-way interaction of group, time and country is significant ($\chi^2(15) = 32.1, p < .01$). Post hoc Tukey tests reveal significant differences between time points for the German mothers only, with decreasing values starting from time 1 (1 vs. 2,3,4 and 2 vs.3, $p < .05$). No significant differences in the father groups and also in any of the Swedish speakers are found. Comparing the countries, significant differences between Swedish and German mothers appear at times 1 and 2, due to the decrease in SFF in the German mothers at the later time points.

For AVS, a significant interaction of country and group was found ($\chi^2(2) = 6.2, p < .05$) with significant differences between Mo and both father groups in both languages ($p < .05$), but higher estimates in the German speakers than in the Swedish speakers (7.5 and 5.6 in German vs. 3.8 and 3.6. in Swedish). When language groups are compared, significant differences were found for mothers (estimate: 5.02, $p < .001$) and Fa males (estimate: 3.04, $p < .05$), but not CFs. In addition, a significant main effect of recording ($\chi^2(3) = 11.69, p < .01$) was found, with a decrease from time 1 to 4 (estimate: 0.75, $p < .05$) and from time 3 to 4 (estimate: 0.8, $p < .05$). Even though group specific variation over time appeared, e.g., with a clearer decrease in German mothers compared to Swedish mothers, the three-way interaction of group, corpus and time failed to show significance ($p = .10$).

4. SUMMARY AND DISCUSSION

Although the countries analysed, Germany and Sweden, are similar in terms of political system, economy, religion and gender equality, even here, a clear difference in self-ascribed femininity was found. In Sweden, which has been at the forefront of providing financial support for both parents following childbirth since the 1970s, females do not differ from males in self-ascribed attributes such as emotional, empathetic or helpful, and this is not due to higher femininity ratings in males, but to lower scores in females. While in Germany some men also rate themselves high on these traditionally female attributes, in Sweden, a lower score in terms of conservative femininity is the accepted standard in females. The difference between

the countries in the construction of gender is reflected in phonetic variation. In both parameters, females revealed lower values in the Swedish than in the German participants, thereby leading to a less clear phonetic gender-specificity. In addition, the German father group which showed heightened femininity ratings (Fa) also showed acoustic characteristics more towards the female values (in SFF and AVS), and thus lies between those of females and CF males. In the Swedish participants the Fa group shows lower femininity and phonetically patterns with the CF group or lies below them. Note though, that conclusions drawn from the Swedish Fa group are limited due to the small participant number.

Thus, results indicate that gender-specific variation in speech is influenced by a culturally affected understanding of gender. In addition, while it has been found that femininity is indexed and perceived through fine phonetic detail in German [13], Swedish speakers do not seem to signal femininity in these phonetic cues. From that we have to ask whether the sociopsychological score we have used does not measure femininity in Sweden correctly or whether Swedish speakers express their femininity in speech through other parameters not measured here.

One rationale for the investigation over time were previous findings showing that British English mothers' SFF decreased during the baby's first year [16]. A potential reason suggested for this variation is the hormonal change after pregnancy with a decrease in estrogen, progesterone, and cortisol levels. The results of the German mothers corroborate this finding, while the Swedish mothers do not exhibit a similar decrease. Although we did not measure hormonal levels, we suggest that these differences between German and Swedish mothers do cast doubt on a mainly hormone-based explanation of the phonetic changes. In addition to the behavioural shifts in self-ascribed femininity that we found, changes in physical and mental fatigue within the baby's first year might lead to lower SFF [24-25] and potentially also hypoarticulated vowels and a smaller AVS [26]. While we did not ask for self-ratings of fatigue or depression, we assessed the involvement in childcare and clear differences between the genders in Germany and between the countries appeared: While in the German group the main part of childcare is done by mothers (irrespective of time and parental leave of the partner), in the Swedish group the participation of both parents (also working CFs) is much more balanced.

The effect of culture-specific gender role concepts and intra-individual variation over time in self-rated gender identity point to a complex interplay of situational changes in life (becoming a parent) and (culture-specific) socio-phonetic variables.

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