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The Interaction of Gender, Occupation, and Fine Phonetic Detail

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Abstract

Does a woman working as a soldier speak in a more masculine manner? And does being told a man is a kindergarten teacher make him 'sound' more feminine to the listener? We explore these questions in two studies examining the production of speech by 36 participants in three gender-(a)typical occupations (soldiers, kindergarten teachers, individuals in leading positions) (Study 1), and the perception of identical speech framed as that of kindergarten teachers or soldiers (Study 2). In addition, the influence of self-ascribed femininity on variation in fine phonetic details is investigated. Results of Study 1 show no differences in mean fundamental frequency between the three occupational groups, but do show a higher second formant (reflecting a more fronted articulation) in kindergarten teachers than in soldiers and leaders, potentially associated with a clearer, friendlier speaking style. Independent of occupation, men who rated themselves high on femininity were found to have higher mean f_0 and more dispersed vowels than men who rated themselves low on femininity. In addition, intra-speaker variation in f_0 patterns was found between same gender and different gender dialogues. Results of Study 2 corroborate stereotypical attributions of warmth depending on the assumed occupation of the speaker. Stimuli assumed to come from kindergarten teachers were rated significantly more friendly and more emotional than the same stimuli assumed to come from soldiers by *younger* listeners, while *older* listeners rated the



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assumed kindergarten teachers as less warm than the assumed soldiers pointing to a change in attitude towards these occupations. Findings are relevant in the light of changing gender roles, occupational stereotypes and the expression of gender through voice.

Keywords

gender, occupation, fine-phonetic detail, voice, stereotypes, personality attributions

Highlights

- While male and female speakers have been found to differ in speech patterns due to both physiological factors and behavioral reasons, this paper changes the focus from analyzing gender as a binary concept to integrating gender expression (femininity) measured on a scale and relates this social factor to variations in fine phonetic detail.
- It is the first study to highlight occupation-specific variation in vowel productions and f0 variation.
- Results of the perception experiment indicate age dependent attitudes towards gender-(a)typical occupations.
- Findings are relevant in the light of changing gender roles, occupational stereotypes and the expression of gender through voice.

Defining gender is a challenging task and while many quantitative studies in the social sciences are related to gender, a conceptualization of gender and how it can be operationalized is an ongoing matter of debate (Lindqvist et al., 2021). While in most fields of the social sciences the use of a binary gender measurement is still common (Westbrook & Saperstein, 2015), gender is not a binary category and the diversity in gender identities is not captured with binary response options (Richards et al., 2017). Apart from defining gender on a binary dimension or by asking people about their gender categories in multiple choice questions, it is also enlightening to look at *gender expression*, which is connected to social gender in terms of norms, regarding both appearance and behavior (Lindqvist et al., 2021). Gender expression deals with individuals' perceptions about their own femininity and masculinity as well as their beliefs about how others view that expression (Magliozzi et al., 2016). In this paper we focus on gender expression through fine phonetic detail—i.e., aspects of voice and articulation, in particular, the pitch of a person's voice and segmental cues such as a clear pronunciation of vowels (see, e.g., Munson & Babel, 2019; Simpson & Weirich, 2020). Variation in fine phonetic detail can be a marker of a person's identity (Eckert, 2012). Here, we investigate the interaction between fine phonetic detail, a person's gender-(a)typical profession¹ (soldiers, kinder-

1) Gender-atypical professions are understood in terms of the frequency of male and female individuals in such positions. We will refer to these groups as male or female dominated occupations.

garten teachers, individuals in leading positions) and a person's gender expression in terms of femininity and masculinity.

Gender-Specific Fine Phonetic Detail

In socio-phonetics, a speaker is understood to use fine phonetic detail for creating their personal speech style and signaling aspects of their identity (Foulkes & Docherty, 2006; Eckert, 2012; Hay & Drager, 2007). Femininity and masculinity are key components of an individual's self-concept, however, gender has long been investigated in (socio-)phonetic research as only a binary factor. Acoustic differences between AFAB and AMAB speakers comprise aspects such as mean fundamental frequency (f_0) (lower in AMAB speakers, Kent et al., 2023), variation in fundamental frequency (less in AMAB speakers, Gisladdottir et al., 2023), vowel acoustics (lower formants in AMAB speakers resulting in a smaller acoustic vowel space and thus less clear speech, Hillenbrand et al., 1995; Weirich & Simpson, 2014), sibilant spectra (lower spectral peaks in AMAB speakers, Flipsen et al., 1999), and temporal aspects (faster speech rates in AMAB speakers, Hillenbrand et al., 1995; Whiteside, 1996). While some of these differences are biological inevitabilities (e.g., lower f_0 in AMAB speakers due to longer vocal folds), cross-language differences in the size of inter-gender differences point to an equally important behavioral and learned component (van Bezooijen, 1995; Johnson, 2006; Weirich et al., 2019). Most linguistic studies still assume AMAB and AFAB speakers to be homogeneous groups, but research focusing on the influence of sexual orientation on speech report mixed findings in regards to within-gender variation (for AMABs see Munson et al., 2006; Sulpizio et al., 2015; Valentova & Havlíček, 2013; for AFABs see Camp, 2009; Moonwomon-Baird, 1997). Pertinent to the work of this study however is the work of Kachel et al. (2017) who showed in their study of German AFAB participants that while differences between lesbians and straight AFAB participants were sometimes absent, within the group of lesbians the first two formants in /i:/ and median f_0 varied depending on gender-role self-concept. Weirich and Simpson (2018) found a correlation between self-ascribed femininity (assessed through the femininity scale of the GEPAQ, the German Extended Personality Attributes Questionnaire, Runge et al., 1981) and phonetic cues for heterosexual AMAB speakers: the more feminine an AMAB speaker rated himself, the higher was his f_0 and the larger his acoustic vowel space (i.e., the clearer his speech). Moreover, listeners were able to attribute femininity correctly using the same acoustic cues. Thus, not only do fine phonetic details correlate with differences between AFAB and AMAB speakers or between speakers with different sexual orientations, but also within these groups, indexing (by speakers) and attributing (by listeners) concepts such as masculinity and femininity (Merritt, 2023). In another study, Weirich and Zahner-Ritter (2023) found a correlation between self-ascribed femininity and F2 (the second formant) which was modulated by city (a correlation was found only in the Eastern Germany group, where the present study also took place, but not in the Western Germany group). They interpret

their findings with respect to different gender role concepts in the two regions (more egalitarian gender roles in Eastern Germany due to different historical developments). These studies highlight the cultural and regional embeddedness of social meaning of phonetic cues and “the cross-language and within-language phonetic arbitrariness of gender” (Johnson, 2006, p. 486).

Speakers can adapt their speech accommodating (phonetically) to different situations, functions, and addressees (Bell, 1984; Hay et al., 2010) to show convergence or divergence (to the situation or the addressee). The Speech Accommodation Theory (SAT, Giles et al., 1991) emphasizes the connection between language use, (gender) identity and situational context. In the present study, we shed light on a potential factor interacting with a speaker’s identity, gender role and speech, i.e., a speaker’s occupation.

Gender, Occupation, and Stereotypes

Whether speech accommodation can also be found in AFAB and AMAB speakers who work in gender-atypical professions with mostly opposite-sex colleagues has not yet been investigated. Several studies have examined the processes of doing (or un-doing) gender at work (Kelan, 2010) in AFAB individuals working in male dominated occupations, e.g., in engineering companies (Angouri, 2011) or in senior management positions (Baxter, 2010). Fewer studies have investigated AMAB individuals in *female*-dominated occupations (e.g. primary school teaching or nursing, but see Bagilhole & Cross, 2006). Particularly relevant to the current study is the limited work conducted on the question of whether and how AFAB and AMAB persons manifest their gender through *language* in such contexts (but see Holmes, 2014). The studies mainly focus on workplace discourse and point to an adaption of gendered speech styles of the “other” to fit into the either male or female dominated working environment and the respective Community of Practice (McDowell, 2015). Some studies have investigated linguistic features such as syntactical or lexical choices of women in leadership positions (Crawford, 2000; Wiley & Eskilson, 1985). However, there is no larger study empirically investigating the interaction between occupation and gender regarding socio-phonetics. Assuming speakers do not show any aversion to their work and their colleagues, the hypothesis is that AFAB speakers in male-dominated work areas exhibit fewer gender-typical speech characteristics (high f_0 , large acoustic vowel space) than AFAB speakers in female-dominated work areas (as they adapt to their male work colleagues). The analogous hypothesis applies to AMAB speakers in female-dominated work environments. Thus, in study 1, we investigate whether differences exist in (gender-specific) fine phonetic detail (f_0 , formants) between male (soldiers, persons in leading positions) and female (kindergarten teachers) dominated occupation groups. Clearly, occupational gender stereotypes (still) exist (Canessa-Pollard et al., 2022; Clarke, 2020). While caregiving professions are linked to femininity (Halper et al., 2019), leadership has been claimed to be connected to masculinity (Koenig et al., 2011). Sczesny et al. (2004), however, also point to a less

traditional view of leadership compared to previous findings, pointing to an ongoing change regarding the link between professions and gender (Eagly & Carli, 2003; Eagly et al., 2020; Schneider & Bos, 2014). Based on previous studies incorporating gender as a fluid concept (Weirich & Simpson, 2018), we also investigate gender-specific fine phonetic detail within AMAB and AFAB speakers, not only due to a speaker's occupation but also due to their self-rated femininity, masculinity, and gender-role concepts.

Stereotypes towards gender-(a)typical occupation groups comprise personality attributions, and often the dimensions warmth and competence are investigated (Strinić et al., 2022). Warmth comprises traits such as friendliness, helpfulness, sincerity and is linked with the concept of communion and thus femininity, while competence reflects capability, intelligence, and ambition and is linked with the concept of agency and thus masculinity (Fiske, 2018). In Study 2, we investigate gender-based stereotypes regarding two occupations lying at the extremities of a masculine–feminine continuum of explicit occupational gender stereotypes (i.e., soldiers and kindergarten teachers) and ask whether these groups differ in their personality attributions regarding competence and warmth –also highlighting potential mediating effects of the listeners' age and gender.

Study Outline

The present paper analyzes fine phonetic details in the speech of participants working in traditionally male or female dominated work environments. The first occupation group consists of *soldiers* working in the German armed forces (Bundeswehr, 86.8% AMAB individuals in 2022, [Deutscher Bundestag \(Wehrbeauftragte/-r\), 2024](#)). All participants were comparable in rank (*Fregattenkapitän, Korvettenkapitän, Oberstleutnant*). The second occupation group consists of *kindergarten teachers* (92.1% AFAB individuals in 2022, [Fachkräftebarometer Frühe Bildung \(WiFF\), 2024](#)). The third occupation group comprises *leaders* and is the most diverse group, including participants who have a leading position in various fields (IT company, intensive care unit, research and consultancy organization, press and public relations and public utilities). The proportion of AFABs in leading positions in 2023 in Germany was 24% ([CRIF GmbH, 2023](#)).

In two studies we investigated aspects of speech production (Study 1) and speech perception (Study 2). In Study 1, we ask whether differences in fine phonetic detail exist between male and female dominated occupation groups and investigate what role gender-related personality dimensions play in gender-specific phonetic variation. In Study 2, we ask whether stereotypes regarding kindergarten teachers and soldiers affect personality evaluations and whether listener characteristics (age and gender) or the gender of the speaker mediate the evaluations.

Study 1: Production Data

Method

Participants

36 participants from three occupational groups took part in the investigation. The occupations were chosen due to their traditional association as either male dominated (soldiers working in military barracks, persons in leading positions) or female dominated (kindergarten teachers). The two male dominated occupation groups were not combined, due to their differing socio-economic characteristics as well as differences in prestige. Participants had to have at least 3 years of experience in their respective occupations to ensure a base level of identification with their job.

Table 1 summarizes participants' age, sexual orientation, years of practice and identification with occupation separated by gender and occupation. Participants were asked to identify their gender as female, male or diverse. As participants chose either female or male, in what follows we will use female and male (in contrast to AFAB and AMAB) with respect to our subjects. Participants rated their identification with their job—on a scale from *not at all* (1) to *very much* (5)—from medium to high (at least 3.3). They had several years of experience in their respective jobs. Sexual orientation was assessed using a Kinsey-like scale (Kinsey et al., 1948) ranging from *exclusively heterosexual* (1) to *exclusively gay/lesbian* (7) or *asexual* (9) to account for potential differences in fine phonetic detail based on sexual orientation (Munson et al., 2006). While most of the participants chose scores leaning towards the heterosexual pole, there was some variation regarding the exclusivity of being heterosexual. Two participants chose 4 and two chose either 5 or 7. Importantly, there is no systematic difference in sexual orientation based on our factor of interest, i.e., the occupation group.

Table 1

Sample Size, Gender, Mean Age, Mean Ratings on Sexual Orientation Scales and Scales on Job Involvement (Years of Practice and Identification With Job)

Occupation	Number of speakers		Mean Age (SD)		Sexual orientation on Kinsey-like scale (SD)				Years of practice (SD)		Identification with job	
	f	m	f	m	f	m	f	m				
Soldiers (<i>Bundeswehr</i>)	3	7	33.7 (1.2)	45.1 (9.4)	1.3 (0.6)	1.3 (0.5)	14.0 (1.0)	25.3 (9.1)	4.0 (1.0)	4.3 (1.0)		
Kindergarten teacher	12	6	45.5 (10.3)	34.2 (4.4)	1.6 (1.2)	2.0 (2.5)	20.1 (15.8)	8.3 (3.6)	4.8 (0.5)	4.8 (0.4)		
Leading position	4	4	44.0 (8.8)	48.5 (6.8)	2.3 (1.9)	1.5 (0.6)	21.0 (7.2)	23.8 (11.7)	4.3 (1.5)	4.5 (0.6)		

To investigate participants' gender expression and to look at potential interactions of gender-related personality dimensions with occupation groups and phonetic variation, three questionnaires were used (chosen based on prior socio-phonetic studies (Kachel et al., 2017; Weirich & Simpson, 2018; Weirich & Zahner-Ritter, 2023)). The Normative Gender Role Orientation scale (NGRO, Athenstaedt, 2000) ranging from *I fully agree* (1) to *I do not agree* (7) was used to assess normative gender role orientation. Femininity (expressivity) and masculinity (instrumentality) was measured using the respective scales F+ (positive attributes traditionally attributed to females) and M+ (positive attributes traditionally attributed to males) of the GEPAQ (Runge et al., 1981) on a scale from, e.g., *dependent* (1) to *independent* (7). Thirdly, identification on the Traditional-Masculinity-Femininity-Scale (TMF) regarding traditional male/female roles (Kachel et al., 2016) was assessed on a scale from *very masculine* (1) to *very feminine* (7).

Cronbach's α of the four scales was medium to high, with the lowest value for NGRO ($\alpha = .70$), followed by GEPAQ_M ($\alpha = .80$), GEPAQ_F ($\alpha = .85$) and TMF ($\alpha = .96$). Figure S1 visualizes the correlation matrix of the gender-scales (significant correlations with $p < .05$ marked with an asterisks). The femininity and masculinity scales of GEPAQ did not correlate, mirroring the independence of these two dimensions. TMF was positively correlated with GEPAQ_F+ (with traditionally more female ratings on TMF corresponding to higher femininity), while GEPAQ_M+ seems to capture other aspects than TMF. NGRO correlated positively with GEPAQ_F+ and negatively with GEPAQ_M+.

For the f0 analysis, 3 female kindergarten teachers were excluded due to their heavy smoking behavior (> 10 cigarettes per day). In combination with their age (> 57) this resulted in very low f0 values (130Hz, 150Hz, 170Hz). Age and smoking behavior do not affect formants in the same way, so all 36 participants were included in the formant analysis, while 33 participants (16 females and 17 males) were included in the f0 analysis (see Table S1, Weirich, 2025a).

Stimuli

Participants were recorded in three cities in East Central Germany (Jena, Erfurt, Dresden). The speech material consisted of two tasks, 1) a reading task with 15 sentences which were repeated twice and 2) a dialogue task, where participants were paired within occupations and given two (out of 6) pictures that varied slightly (see Figure S2, Weirich, 2025a). Since it has been shown that speakers adapt to interlocutors and situations (Bell, 1984; Giles et al., 1991), participants were recorded in their respective occupational role speaking to a colleague (in the kindergarten, in the offices of the leaders, in the military barracks).

The sentences of the reading task contained target words particularly suitable to measure formant values in peripheral vowel qualities in stressed syllables (such as /i:/ in *Biene* (bee), /a/ in *Tasse* (cup), /u:/ in *Luka* (first name)). For the dialogue task, custom-made pairs of pictures were used showing objects and animals with vowels in stressed

syllables (e.g., /i:/ in *Liege* (lounger), /a/ in *Tasche* (bag), /u:/ in *Kuh* (cow), see Table S2 for all included vowels and words, Weirich, 2025a). Participants were asked to find differences between scenes by talking about their pictures (“Spot the difference”). Thus, the conversation between participants was a task-oriented dialogue in a game form to encourage free communication, often used in studies on accommodation (Pardo, 2006). All recordings were made using a headset microphone (DPA, CORE Omni Headset) connected to a ZOOM–H6 Handy Recorder, making it possible to have separate high quality audio signals for the participants necessary for the acoustic analyses. The dialogues lasted on average 11.75 min ($SD = 5.6$ min).

Analysis

Prior to acoustic analyses, the speech data was orthographically transcribed and further segmented automatically into words and segments using MAUS via its online interface WebMAUS Basic (Kisler et al., 2017). All acoustic analyses were performed using PRAAT (Boersma & Weenink, 2015). Mean f_0 and standard deviation (SD) of mean f_0 were measured for each participant separately for the two speech tasks². For the dialogue task, speech data was manually segmented to mark stretches of speech with only the main participant speaking. Several sequences for each speaker of the whole dialogue were annotated and for each of these sequences mean f_0 and SD (var f_0) was calculated (see Table S3, Weirich, 2025a). Most participants did the dialogue task only once with a colleague of a different gender (DG condition). Seven participants (2 males) could be recorded in the same gender condition (SG) only. In six cases (4 males/2 females), the participants were recorded in both conditions (SG and DG). In total, 2 x 1,578 f_0 measurements (2 x 442 for soldiers, 2 x 438 for kindergarten teachers, 2 x 720 for leaders) were gathered for the dialogue speech. For the investigation of an influence of the interlocutor’s gender only a subset of the data was used (the six soldiers which were recorded in both DG and SG condition).

For read speech, only one value per parameter was used for each speaker (the average f_0 estimated across the reading task (=mean f_0) and the standard variation of the f_0 measurements across this task (=var f_0)).

Formant frequencies (F1, F2) were measured at the midpoint of the labeled vowels using PRAAT’s LPC formant measurement algorithm³. The acoustic vowel space of a speaker was represented using the five tense peripheral vowels /i: e: a u:/. For read speech, 2,037 vowel tokens (1,083 of female participants) were included in the analysis. Only vowels with a high number of replications contained in stressed syllables were

2) analysis parameters: time step = 0.01; minimum pitch for males = 50 Hz, for females = 75 Hz; maximum pitch for males = 350 Hz, for females = 450 Hz

3) analysis parameters: time step = 0.01s; maximum number of formants = 5; window length = 0.025s; preemphasis from = 50 Hz; maximum formant value for males = 5000 Hz, for females = 5500 Hz

chosen. Formants were manually corrected where necessary (especially for /u:/). The number of vowels varied slightly between speakers (from 57 to 63), and two speakers repeated the sentence list only once resulting in the lowest number ($n = 29$ for FK_M02 and FK_F01).

For the dialogue task, formants (F1 and F2) in 2,145 vowel tokens (1,102 from female speakers) were measured. Analogous to the f_0 analysis, each participant was included only once. Due to the nature of the speech material (a spontaneous dialogue is less controlled than read speech and contains more speech errors, hesitations, overlapping speech) more formants were incorrectly measured than in the read speech and, thus, were not manually corrected but removed from the data set as outliers. For each vowel and formant, the interquartile range (IQR) (difference between the 75th percentile (Q3) and the 25th percentile (Q1)) was measured. An observation was considered to be an outlier if it was 1.5 times the interquartile range greater than the third quartile (Q3) or 1.5 times the interquartile range less than the first quartile (Q1). After outlier exclusion, 1,760 vowel tokens were subjected to the analysis.

For statistical analyses, linear (mixed) models in the R environment (R Core Team, 2020) were run. Test variables were added successively to the model using a forward stepwise regression. p -values were estimated using model comparisons, i.e., by comparing models with and without the respective variables or interactions in question using likelihood ratio tests provided by the *anova* function (package *lme4*, Bates et al., 2015). Summaries of the final models are given in the Supplementary Materials (see Tables S4–S23, Weirich, 2025a). For post hoc comparisons, the package *emmeans* was used (Lenth, 2022). Pearson correlations were run after testing for normal distributions (Shapiro-Wilk normality tests, all p -values $> .10$) of the respective variables (e.g., mean f_0 , GEPAQ_F+).

Results

Gender-Related Scales

Table 2 shows mean values and SDs of the gender variables separated by gender and occupation. The numbers only point to clear gender differences for TMF, while all other scales show similar values between the groups or do not differ with respect to gender but rather to occupation (higher masculinity in male leaders and in male soldiers than in female leaders and female soldiers but lower masculinity in male kindergarten teachers than female kindergarten teachers). Accordingly, the linear model revealed a significant effect of GENDER for TMF, $F(1) = 87.12$, $p < .001$, and also—with a much smaller effect size—for GEPAQ_F+, $F(1) = 7.4$, $p = .01$, but not for GEPAQ_M+, $F(1) = 0.9$, $p = .35$, nor for NGRO, albeit marginal, $F(1) = 3.4$, $p = .07$. While the table reveals job specific variation in gender differences in GEPAQ_F+ (higher femininity in female soldiers and teachers compared to their male counterparts but lower femininity in female leaders than male leaders), including the interaction of GENDER*OCCUPATION into the model failed to reach significance, $F(2) = 2.1$, $p = .099$. For GEPAQ_M+ the table reveals lower values

for teachers compared to the other groups, but the factor OCCUPATION marginally failed to reach significance $F(2) = 3.1, p = .056$. For NGRO and TMF, including neither OCCUPATION as a main factor nor the interaction of OCCUPATION *GENDER revealed a better fit ($p > .35$).

Table 2
Overview Over Participants' Scores on Self-Rated Gender-Related Scales

Occupation group	N		NGRO (SD)		TMF (SD)		GEPAQ_F+ (SD)		GEPAQ_M+ (SD)	
	f	m	f	m	f	m	f	m	f	m
Soldiers	3	7	6.1 (0.8)	5.8 (0.7)	5.9 (0.7)	2.2 (0.6)	6.6 (0.1)	5.2 (0.9)	5.2 (0.8)	5.6 (0.9)
Kindergarten teachers	12	6	6.3 (0.5)	6.0 (0.9)	5.6 (1.1)	3.1 (1.1)	6.1 (0.6)	5.4 (0.6)	5.0 (0.9)	4.7 (0.6)
Leaders	4	4	6.0 (0.4)	5.5 (1.0)	5.3 (1.0)	2.4 (0.9)	5.3 (0.7)	5.6 (0.5)	5.3 (0.5)	5.9 (0.6)

Note. Rated from 1 to 7. NGRO = Normative Gender Role Orientation; TMF = Traditional-Masculinity-Femininity Scale; GEPAQ_F+/M+ = Positive Femininity and Masculinity scale of the German Extended Personality Attributes Questionnaire.

Effect of Occupation on Fundamental Frequency

Summary statistics with f0 values averaged across occupation group and task are given in Table S3 (see Weirich, 2025a). Separate linear (mixed) models were run for the speech tasks with either MEAN f0 or VAR f0 as dependent variable. For MEAN f0 and the dialogue task, the LMM (with SPEAKER and SEQUENCE as random intercepts) revealed the expected effect of GENDER, $\chi^2(1) = 61.7, p < .001$, while adding OCCUPATION did not result in a better fit of the model ($p > 0.7$). Similarly, for VAR f0 and the dialogue task, the LMM (with SPEAKER and SEQUENCE as random intercepts) shows an effect of GENDER, $\chi^2(1) = 28.01, p < .001$. The interaction of GENDER *OCCUPATION failed to show significance, $\chi^2(4) = 7.23, p = .12$.

For read speech, linear models were run (since only one f0 measurement per speaker was measured). For MEAN f0, a significant effect of GENDER was found, $F(1) = 138, p < .001$, while adding OCCUPATION did not lead to a better fit ($p > .8$). For VAR f0, both GENDER, $F(1) = 9.49, p = .004$, and OCCUPATION, $F(2) = 4.54, p = .019$, showed a significant effect. Post hoc comparisons revealed significant differences between leaders and kindergarten teachers, mean L = 35.7 (SE = 2.57), mean K = 26.4 (SE = 1.192), Estimate = -9.29, $df = 27, p = .019$, with leaders showing higher variation than teachers. All other comparisons were not significant ($p > .17$).

Effect of the Interlocutor's Gender on Fundamental Frequency

Table 3 gives a summary of the f0 measurements separated by speaker and dialogue condition (DG, SG). The linear mixed model with SPEAKER and SEQUENCE as random factors and MEAN f0 as the dependent variable revealed a significant interaction of SPEAKER GENDER and the GENDER of the DIALOGUE PARTNER, $\chi^2(2) = 6.18, p = .045$,

with females having *higher* mean f0 values in the DG condition than in the SG condition and males having *lower* mean f0 values in the DG condition than in the SG condition. This is reflected in the values presented in Table 4 (except for one speaker: M03). Thus, the contrast between the genders in mean f0 is *increased* in the DG condition. For VAR f0, the interaction marginally failed to reach significance, $\chi^2(2) = 4.61, p = .099$, but the numbers in Table 3 also show a gender specific pattern: while females show a decrease in variation in f0 in the DG pairs, males show a slight increase in variation in f0.

Table 3
Mean f0 and Variation in f0 (Both in Hz) in the Dialogue Task Separated by Speaker and Dialogue Condition

Speaker	Sex	Condition	n	Mean f0 (SD)	Var f0 (SD)
BW_F01	F	DG	60	204 (30.3)	45.9 (26.9)
BW_F01	F	SG	14	199 (8.3)	50.9 (9.9)
BW_F02	F	DG	37	178 (16.7)	33.0 (10.2)
BW_F02	F	SG	23	173 (14.1)	38.4 (9.6)
BW_M01	M	DG	20	101 (7.1)	23.5 (7.4)
BW_M01	M	SG	15	108 (4.8)	22.3 (4.9)
BW_M02	M	DG	31	118 (12.2)	20.8 (7.6)
BW_M02	M	SG	15	127 (8.5)	13.1 (6.8)
BW_M03	M	DG	33	105 (11.5)	23.8 (8.0)
BW_M03	M	SG	14	104 (7.6)	22.9 (3.2)
BW_M04	M	DG	16	106 (8.0)	21.4 (3.0)
BW_M04	M	SG	14	113 (11.1)	20.6 (7.7)

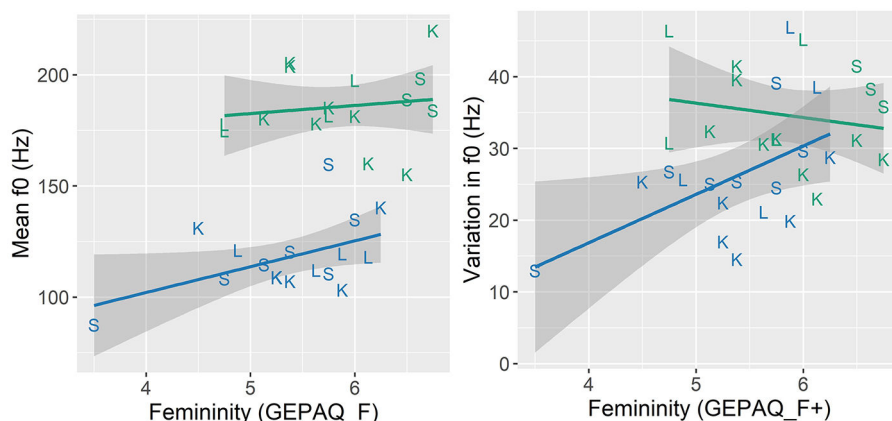
Note. SG = same gender; DG = different gender.

Effect of Femininity on Fundamental Frequency

To investigate the relationship between self-rated femininity (GEPAQ_F) and f0 parameters, mean f0 and mean variation in f0 were estimated for each speaker from the reading task. Pearson correlations were run between the f0 measures and GEPAQ_F+ scores for males and females separately. For males, a significant positive correlation was found between FEMININTY and MEAN f0, with speakers who rate themselves as more feminine also having a higher mean f0 ($r = .49, p = .024, df = 15$). In addition, a significant correlation was found between VAR f0 and FEMININTY, with more feminine men having a higher variation in f0 ($r = 0.53, p = .014, df = 15$). For females, no such relationship was found, neither for mean f0 ($r = .15, p = .29, df = 14$) nor for variation in f0 ($r = -.19, p = .768, df = 14$). Figure 1 visualizes the relationships, also giving information about the occupation of the respective speaker.

Figure 1

Mean f_0 (Hz) as a Function of Self-Rated Femininity (GEPAQ_F+) for Male (Blue) and Female (Red) Speakers



Note. Occupation of speakers marked by letters. K = kindergarten teachers; L = leaders; S = soldiers.

We also investigated the relationship between f_0 parameters and masculinity (GEPAQ_M), but no significant correlation was found (all $p > .22$). Since both NGRO and TMF correlated positively with GEPAQ_F we did not run further correlations.

Effects of Occupation on Formant Values

Linear mixed models with SPEAKER and WORD as random intercepts were run separately for F1 and F2. For read speech and F2, a significant interaction of VOWEL*GENDER*OCCUPATION was found ($\chi^2(11) = 198.96$, $p < .001$). Post hoc comparisons were run to detect for which gender and vowels occupation groups differ (since we are not interested in the expected differences between vowels and genders, but instead in any occupation specific productions). Significantly higher F2 values were found for female kindergarten teachers than for female soldiers for /e:/, mean K = 2376 (SE = 72.3), mean S = 2156 (SE = 87.2), Estimate = 220.5, $df = 60.4$, $p = .002$, and also for /i:/, mean K = 2486 (SE = 51.3), mean S = 2305 (SE = 65.0), Estimate = -180.9, $df = 39.7$, $p = .007$. In addition, for /e:/, female kindergarten teachers also showed higher F2 values than female leaders, mean K = 2376 (SE = 72.3), mean L = 2207 (SE = 83.4), Estimate = 168.9, $df = 56.7$, $p = .011$. For males, kindergarten teachers differed from soldiers by showing higher F2 values for /a/, mean K = 1368 (SE = 48.3), mean S = 1252 (SE = 46.5), Estimate = 115.7, $df = 35.1$, $p = .047$. To sum up, the group of kindergarten teachers stood out in terms of higher F2 values than the other groups (mediated by vowel and gender).

For read speech and F1, again a significant interaction between VOWEL*GENDER*OCCUPATION was found, $\chi^2(11) = 48.2$, $p < .001$. Post hoc comparisons revealed

significant differences between female kindergarten teachers and female leaders for /a/, with leaders showing higher F1 values than kindergarten teachers, mean L = 811 (SE = 19.7), mean K = 751 (SE = 14.4), Estimate = 60.18, SE = 19.5, $df = 37.3$, $p = .01$. All other comparisons between occupations had p -values larger than .16.

For the dialogue task and F2—similar to the read speech data—the LMM with the interaction of OCCUPATION*GENDER*VOWEL explained the data best, $\chi^2(11) = 108.49$, $p < .001$. Similar to read speech, the female kindergarten teachers stood out by having higher F2 values for /e:/ than soldiers, mean K = 2449 (SE = 43), mean S = 2231 (SE = 61.5), Estimate = -217.42, $p < .001$, and also leaders, mean L = 2290, Estimate = -158.57, $p = .01$. In males, a tendency was found for kindergarten teachers to show higher F2 values than soldiers ($p = 0.16$).

Also for F1, a significant interaction of VOWEL*GENDER*OCCUPATION was found, $\chi^2(19) = 121.12$, $p < .001$. In male speakers, the leaders exhibited higher F1 values for /a/ than soldiers, mean L = 652 (SE = 16.5), mean S = 600 (SE = 13.7), Estimate = 52.5, $p = .022$, and also tendentially higher than kindergarten teachers, mean K = 604 (SE = 17.2), Estimate = 48.5, $p = .078$. There was also a tendency for female soldiers to show higher F1 values than kindergarten teachers for /e:/, mean S = 399 (SE = 18.9), mean K = 354 (SE = 12.9), Estimate = 45.3, $p = .055$.

To sum up, for both read and dialogue speech, male leaders had higher F1 values than the other occupation groups, while for F2 female kindergarten teachers exhibited higher values.

Effect of the Interlocutor's Gender On Formant Values

Analogous to the f0 analysis, we looked for an effect of interlocutor's gender on F1 and F2. LMMs with SPEAKER and WORD as random intercepts were run. For both, F1 and F2 the expected significant interaction of VOWEL*GENDER was found, F1: $\chi^2(3) = 108.8$, $p < .001$, F2: $\chi^2(3) = 54.23$, $p < .001$, indicating phone-specific differences between male and female speakers. In contrast to f0, adding the factor of the INTERLOCUTORs GENDER (same vs. different gender) did not reveal a better fit of the data (p -values > .37).

Effect of Femininity On Formant Values

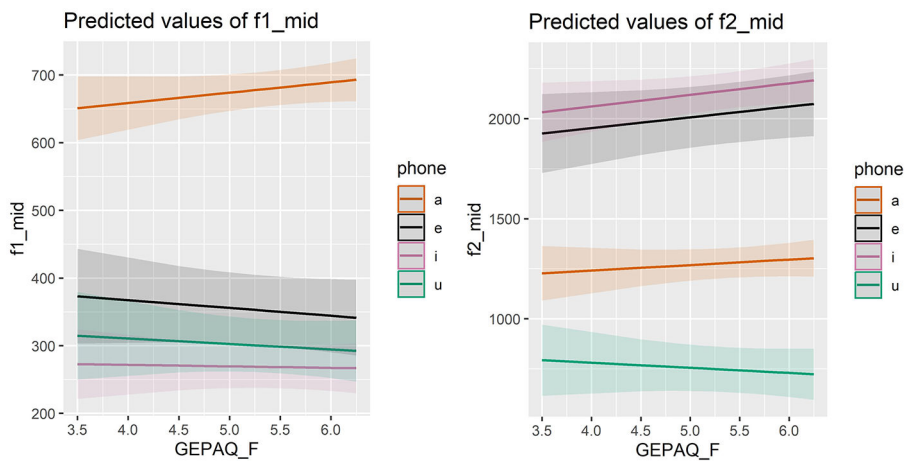
To explore the relationship between self-rated femininity (GEPAQ_F) and formants (F1, F2) measurements from the reading task were used for each speaker. LMMs were run for male and female speakers separately with either F1 or F2 as dependent variable and WORD and SPEAKER as random effects.

For male speakers and both F1 and F2, the model with the interaction of VOWEL*GEPAQ_F explained the data better than the model with VOWEL alone, F1: $\chi^2(4) = 12.476$, $p = .014$; F2: $\chi^2(4) = 12.95$, $p = .011$. Figure 2 visualizes the effect of femininity on F1 (left plot) and F2 (middle plot) separated by vowel: higher femininity is reflected in higher F1 values for /a/, which corresponds to a lower tongue and jaw position and thus a

clearer pronunciation of /a/, while for the high vowels /e:/, /i:/ and /u:/ the direction is the other way, also pointing to a larger vowel space and thus a clearer speaking style with higher femininity values. In addition, higher femininity is reflected in higher F2 values, especially for the front vowels /e:/ and /i:/ but also for /a/, while for the back vowel /u:/ the direction is the other way. Higher F2 values in front vowels and lower F2 values in back vowels correspond to a larger vowel space and thus a clearer speaking style. For both formants, higher femininity ratings are reflected in values shifted towards more female speech (higher formants in females than in males, clearer speaking style in females).

Figure 2

Model Predictions of the Interaction Effect Between Femininity (GEPAQ_F) and Vowel Quality (/a e i u/) on F1 (Left) and F2 (Right) in Male Speakers' Read Speech



For female speakers and F1, the expected significant effect of VOWEL was found, $\chi^2(3) = 73.85$, $p < .001$, but adding GEPAQ_F to the model did not result in a better fit ($p > 0.5$). For female speakers and F2, the interaction of VOWEL*GEPAQ_F turned out to be significant, $\chi^2(4) = 18.15$, $p = 0.001$: while F2 for /i:/ decreases with higher femininity, F2 increases with higher femininity for /u:/. This contrasts with the male patterns and the expected relationship between femininity and clear speech.

Study 2: Perception Data

Method

Participants

130 participants took part in the listening experiment which was run using the online platform *SosciSurvey* (Leiner, 2018) and lasted approximately 15 minutes. Participants over a wide age range were recruited in university classes, over social media as well as through diverse contacts of the author and colleagues (e.g., family, friends, sports clubs, orchestra, etc.).

Participants were given information about the supposed aim of the study, i.e., investigating personality attributions based on voices. Crucially, descriptions differed in the priming of the listeners regarding the supposed speakers: Listener group 1 was told that recordings were made in a kindergarten, while listener group 2 was told that recordings were made in military barracks. In addition, for each stimulus to be rated in the experiment the question was prefaced with “Please rate the kindergarten teacher” for the first listener group and “Please rate the soldier” for the second listener group. Note that in this priming experiment, the leader category was not used. Listeners were told that there were no right, or wrong answers and they should decide intuitively. In addition, participants were asked about their age, mother tongue, where they lived, educational background, gender (by choosing female, male, non-binary or no answer) and sexual orientation (to be rated on a Kinsey-like scale).

Table 4 gives a summary of participants’ background separated by priming condition and age group. In a previous study (Weirich et al., 2020), listeners’ age was found to be a relevant factor regarding stereotypical assumptions about speaker groups. Therefore, age was added as a potential factor exploratorily investigating differences in the prestige of occupational groups.

Table 4
Overview Over Number, Gender, Age and Sexual Orientation of the Participants of the Rating Experiment

Priming	Age group	N			Age (SD)	Sexual orientation on Kinsey-like scale (SD)
		f	m	nb		
Soldiers (S)	Younger	15	17	1	24.4 (4.1)	2.64 (1.8)
Soldiers (S)	Older	19	12	1	52.6 (11.3)	1.75 (1.6)
Kindergarten (K)	Younger	15	11	0	25.5 (4.0)	1.81 (1.0)
Kindergarten (K)	Older	22	17	0	47.8 (9.4)	1.54 (1.3)

Note. f = female; m = male; nb = non-binary. 1 exclusively heterosexual – 7 exclusively gay/lesbian.

A pretest was run to familiarize participants with the experimental design. After the main experiment participants were thanked and the true aim of the investigation was explained.

Stimuli

Acoustic stimuli came from 10 males (5 soldiers, 5 kindergarten teachers) and 10 females (3 soldiers, 7 kindergarten teacher) and consisted of the sentence “Der Hase frisst die Möhre” (The rabbit eats the carrot). These stimuli were part of the reading task elicited in the production study. By using sentences as stimuli, listeners were provided with both segmental cues (such as vowel formants, sibilant spectra) and supra-segmental information (such as mean f_0 , variation in f_0 , speaking tempo) known to be used for speaker attributions such as gender, femininity, or personality (Klofstad et al., 2012; Weirich & Simpson, 2018).

Procedure

The procedure of the perception test was the same for both priming groups and each stimulus. A text was presented asking the participant to rate the (assumed) kindergarten teacher (priming group = K) or the (assumed) soldier (priming group = S) based on their voice. Participants could listen to each stimulus several times but were still asked to rate fast and intuitively. 8 bipolar item pairs were provided with the possibility to rate the stimulus regarding each of these item pairs on a 7-point scale. The items were chosen to reflect the personality dimensions *warmth*⁴ and *competence*⁵ oriented on the stereotype Content Model (Fiske, 2018). The positive poles of the item pairs were randomly assigned to the left or right side of the scale, and the order of the items was kept constant for each stimulus and listener. When a listener had rated a stimulus, the next stimulus was presented, again providing the written explanation and naming the prime (soldier vs. kindergarten teacher). Altogether, each of the 130 listeners rated 20 different speakers, resulting in 2600 ratings (x 8 items) used for the analysis.

Analysis

Cronbach’s alpha was measured to estimate reliability for the items used for the personality dimensions *warmth* and *competence* resulting in high values for both scales (.88 and .83 respectively). Mean values for the two dimensions were calculated across all respective items and used in linear mixed models as dependent variables using the R environment (R Core Team, 2020). Test variables were added successively to the model using a forward stepwise regression. Summaries of the final models are given in the

4) Consisting of the items warm – cold, likeable – unlikeable, sensitive – insensitive, emotional – unemotional

5) Consisting of the items competent – incompetent, self-confident – insecure, dominant – submissive, ambitious – aimless

Supplementary Materials (see Tables S24–S25, Weirich, 2025a). p -values were estimated using model comparisons, i.e., by comparing models with and without the respective variables or interactions in question using likelihood ratio tests (lme4, Bates et al., 2015). LISTENER and SPEAKER were included as random intercepts. We tested for the effects of PRIMING, AGE GROUP, LISTENER GENDER and SPEAKER GENDER. For post hoc comparisons, the package *emmeans* was used (Lenth, 2022).

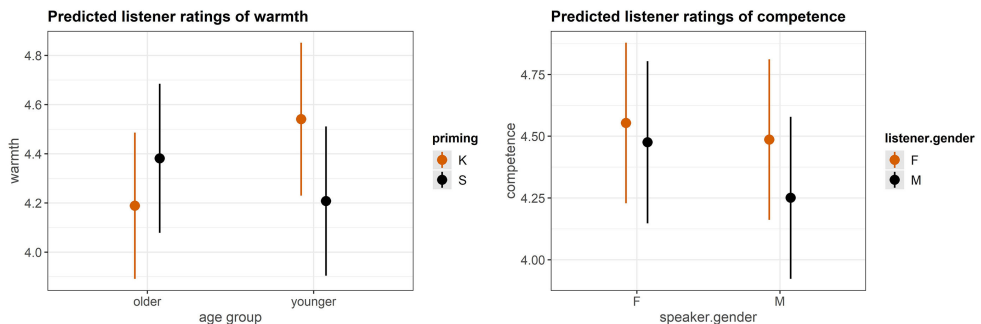
Results

Evaluation Ratings

For *warmth*, a significant effect of LISTENER GENDER, $\chi^2(3) = 11.5$, $p = 0.009$, and an interaction of PRIMING * AGE GROUP, $\chi^2(3) = 17.5$, $p < .001$, was found. Female listeners rated the speakers to be warmer than male listeners (Estimate = -0.22652, SE = 0.0675, $df = 171.23$, $p < .001$), independent of age group, speaker gender and priming. Furthermore, younger listeners rated supposed kindergarten teachers to be warmer than supposed soldiers, mean K = 4.51 (SE = 0.20), mean S = 4.19 (SE = 0.19), Estimate = 0.321, $p = .002$, while older listeners rated supposed soldiers to be warmer than supposed kindergarten teachers, mean K = 4.16 (SE = 0.19), mean S = 4.34 (SE = 0.19), Estimate = -0.182, $p = .025$, see Figure 3 (left plot).

Figure 3

Model Predictions



Note. Left plot: Model predictions of the interaction effect between age group and priming on the personality dimension warmth. Right plot: Model prediction of the interaction effect between speaker and listener gender on the personality dimension competence.

For competence, no effect of priming or age group was found, but the speakers' gender and the listeners' gender affected the ratings. Here, we excluded the two non-binary listeners due to their low number in comparison to the female and male participants. The model with the best fit of the data included the interaction of SPEAKER*GENDER*LIS-

TENER GENDER, $\chi^2(3) = 11.01$, $p = .012$, see Figure 3 (right plot). *Male speakers* were more positively rated in terms of higher competence by female listeners in comparison to male listeners, mean female listeners = 4.49 (SE = 0.17), mean male listeners = 4.25 (SE = 0.17), Estimate: 0.236, $p = .002$. For *female speakers*, the gender of the listener had no significant effect, mean female listeners = 4.55 (SE = 20.9), mean male listeners = 4.48 (SE = 21.6), Estimate = 0.078, $p = .289$.

General Discussion

In Study 1 we investigated variation in fine phonetic detail in relation to a speaker's gender-(a)typical occupation (soldiers, kindergarten teachers, individuals in leading positions), his/her self-ascribed femininity and the sex of the interlocutor. In Study 2 we investigated the perception of identical speech framed as that of kindergarten teachers or soldiers.

In Study 1, no effect of occupation on mean f_0 was found, even though other studies have found f_0 to influence the perception of leadership capacity in both AMAB and AFAB speakers (Klofstad et al., 2012; Moore, 2016). A tendency for occupation specific f_0 modulation was found: male leaders exhibited *more* f_0 variation and females *less* f_0 variation than the other occupations resulting in smaller gender differences in leaders than in the other groups. This is in line with studies on AFAB politicians who have been found to conform to a masculine communication style (Boussalis et al., 2021; Moore, 2016). The decrease in gender difference also reflects findings on strategies of AFAB politicians suffering some disadvantages from prejudicial evaluations of their competence as leaders and thereby aiming to appear more "gender-less" (e.g. Eagly & Carli, 2003; Schneider & Bos, 2014).

Occupation differences were shown for vowel formants: for F1 it is the male leaders that show differing behavior, by having higher values than the other occupation groups. Higher F1 values point to a more open jaw and a clearer speaking style. For F2, the kindergarten teachers differed from the other groups by having higher values (mediated by phone and gender) in read and dialogue speech. Higher F2 values correspond to a more fronted articulation also resulting from spread lips. This points to the possibility of a more friendly speech style (indicated by smiling during speech which is generally accompanied by more spread lips and a higher F2). Research on infant-directed speech (IDS) has found an increase in the acoustic vowel space reflected by higher formant values in IDS compared to ADS, which has been explained both in terms of a clearer and affective speaking style in IDS (Benders, 2013). While in the present study no clear picture for F1 was found, the higher F2 values in the kindergarten teachers might still be affected by using IDS at work. Additionally, stronger relationships have been found between femininity and F2 than between femininity and F1 (Kachel et al., 2017; Weirich & Simpson, 2019; Weirich & Zahner-Ritter, 2023).

Interesting patterns arose regarding the effect of the interlocutor's gender in dialogues on f_0 : For mean f_0 , the gender difference *increased* (with males having lower f_0 in DG compared to SG dialogues and females having higher f_0 in DG compared to SG). For variation in f_0 , the gender difference *decreased* in DG compared to SG (while not significantly). Speakers adapt their speech accommodating phonetically to different addressees (Bell, 1984) thereby showing convergence or divergence (SAT, Giles et al., 1991) to establish a desired social stance (Babel et al., 2014). While the larger contrast in mean f_0 in DG might be used to emphasize differences in femininity/masculinity, the accommodation in variation in f_0 might reflect communicative behavior and adaptation to interlocutors in dialogues.

Regarding the personality dimensions clear differences between the genders were found for TMF only, while for GEPAQ-F+ interesting occupation patterns arose (e.g., second lowest femininity score in female leaders, only male soldiers had lower values). Thus, the difference between AFAB and AMAB persons in self-ascribed femininity as measured by GEPAQ-F+ (using personality items such as friendly or helpful) becomes smaller in Western cultures (as it has been found for communality and agency Hsu et al., 2021). The more recently developed TMF-scale—capturing self-ascribed ratings on how masculine/feminine people see themselves, how they want to be or how others see them—distinguished well between our male and female participants (similarly to Weirich & Simpson, 2018).

Femininity measured by GEPAQ-F+ influenced phonetic parameters, corroborating earlier findings (e.g., Merritt, 2023; Weirich & Simpson, 2018; Weirich & Zahner-Ritter, 2023). Males with higher femininity scores showed higher mean f_0 values and more variation in f_0 . Also, males who perceived themselves high on femininity had formant values shifted towards a clearer speaking style thus more female speech. In females, results were less clear with contrasting directions for F2 (more centralized values for /i/ and /u/). AMAB speakers with lower mean f_0 have been rated as taller, stronger, more formidable, more masculine, more attractive and more dominant (Schild et al., 2020; Weirich & Simpson, 2018). Thus, it may be more important for AMAB than for AFAB speakers to use vocal cues to index these characteristics.

A potential interacting factor on the relationship between vocal cues and masculinity/femininity is the testing site. Cultural/regional differences in gender concepts have been linked to differences in the size of gender-specific phonetic variation (van Bezooijen, 1995; Johnson, 2006; Passoni et al., 2022; Weirich & Simpson, 2023). While in the study of Weirich and Zahner-Ritter (2023) the link between self-ascribed femininity and vocal cues was missing in a city in western Germany (i.e. Trier, with more conservative gender role concepts), a significant correlation was found in eastern Germany (i.e. Jena, with more egalitarian gender role concepts). Jena was also one of the cities included in the present study, and the results were replicated with two other cities in eastern Germany (Dresden, Erfurt). Together, results point to the embeddedness of the

concept of femininity in phonetic cues in eastern Germany (with more egalitarian gender role concepts based on historical developments). More research is needed to support this claim.

Regarding Study 2, the priming revealed gendered stereotypes toward the occupation groups kindergarten teachers and soldiers that were mediated by age group. While younger listeners rated supposed kindergarten teachers as *warmer* than supposed soldiers, this trend was reversed for older listeners—pointing to a change in attitude towards gendered occupation groups (cf. Schneider & Bos, 2014; Sczesny et al., 2004). Differing experiences of the age groups might be a reason. The education system has changed throughout the last 50 years, with kindergarten teachers being less strict today than they were when the older listeners (Mean age: 50.2 years) were young (Urban et al., 2012). Another possibility is a changing attitude towards the group of soldiers, who might have a higher prestige for older listeners (who probably also had more contact with this group due to military service, which was obligatory for young men until 2011). Changes in occupational prestige can evolve during times of social change, see, e.g., changes in perceptions of prestige in care professions or in “key workers” during the COVID-19 pandemic (De Camargo & Whiley, 2020).

Regarding the attribution of *competence*, listeners’ and speakers’ gender played a role: *male speakers* were more positively rated by female listeners in comparison to male listeners, while for *female speakers*, the gender of the listener had no effect. AFAB persons have been found to be less competitive and perform worse in competitive settings than AMAB persons (Saccardo et al., 2018; Shurchkov, 2012), which has been taken as an explanation for the differential success between AFAB and AMAB persons in the labor market (Croson & Gneezy, 2009). The more negative ratings of our male listeners regarding competence in general and regarding their own sex might reflect this gender gap in competitiveness.

Conclusion

Our findings are relevant in the light of changing gender roles, occupational stereotypes and the expression of gender through voice. The study is the first that highlights occupation specific variation in vowel productions and f_0 variation. Moreover, the influence of the interlocutor’s gender in dialogues was shown and the impact of femininity on variation in fundamental frequency and vowel formants in males. Results of the perception experiment indicate age dependent attitudes towards gender-(a)typical occupations. Future research should include other occupations and also investigate situation specific style-shifting phenomena.

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Competing Interests: The author has declared that no competing interests exist.

Ethics Statement: The data collected and experiments conducted were part of a larger project which was reviewed and approved by the Ethics Committee of the University of Jena (2019-1389-BO). Informed consent has been obtained from all respondents prior to their participation in the study.

Data Availability: Datasets (csv-tables) and corresponding codebook are included in the Supplementary Materials (see [Weirich, 2025b](#)). The database consisting of audio recordings of read speech and dialogues of 36 participants (19f / 17m) from three occupational groups (kindergarten teachers, soldiers, leaders) will be available through the JeCoP (Jena Corpora) database once the project is finished. JeCoP is hosted by the Institute for German Linguistics at the University of Jena. It is a password protected, browser-based and searchable database accessible by researchers interested in the data for scientific analyses. It includes audio recordings, orthographic and phonetic transcripts, and socio-demographic meta-data such as age, sex assigned at birth, mother tongue, self-rated femininity, etc. The JeCoP database uses the LaBB-Cat infrastructure. LaBB-CAT was designed and written by Robert Fromont and Jen Hay for the New Zealand Institute of Language, Brain and Behaviour (NZILBB) at the University of Canterbury, Christchurch, New Zealand ([Fromont & Hay, 2012](#)).

Supplementary Materials

For this article, the following Supplementary Materials are available:

- Supplementary tables and figures (see [Weirich, 2025a](#))
- Research data, codebook (see [Weirich, 2025b](#))
- R scripts (see [Weirich, 2025c](#))
- Readme file with detailed information on all Supplementary Materials

Index of Supplementary Materials

Weirich, M. (2025a). *Supplementary materials to "The interaction of gender, occupation, and fine phonetic detail"* [Tables, figures]. PsychOpen GOLD.

<https://doi.org/10.23668/psycharchives.16354>

Weirich, M. (2025b). *Supplementary materials to "The interaction of gender, occupation, and fine phonetic detail"* [Data, codebook]. PsychOpen GOLD.

<https://doi.org/10.23668/psycharchives.16355>

Weirich, M. (2025c). *Supplementary materials to "The interaction of gender, occupation, and fine phonetic detail"* [Code]. PsychOpen GOLD. <https://doi.org/10.23668/psycharchives.16356>

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