

# ON THE REALIZATION OF SCHWA IN TWO VARIETIES OF STANDARD GERMAN

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## ABSTRACT

The present study investigates the realization of the central vowel in Northern Standard German and Austrian Standard German. An acoustic formant analysis of professional and non-professional speakers shows different realizations of this vowel in both varieties (more central vs. more fronted). In contrast to earlier reports a subgroup of non-professional Austrian speakers tends to realize a schwa as it is usual in Northern Standard German.

**Keywords:** linguistic phonetics, phonology, acoustic analysis, German

## 1. INTRODUCTION

The vowel systems of the languages of the world provide a wide range in complexity from languages utilizing only two or three phonologically distinctive vowels (e.g. Abchaz [7]) to systems of more than twenty vowel categories. Most common are systems of about five distinct vowels [13]. Germanic vowel systems are larger in general, including Standard German with 15 monophthongs able to bear word stress (/i:, ɪ, e:, ε, ε:, a:, ʌ, o:, ɔ, u:, ʊ, y:, ʏ, ø:, œ/) [10].

As can be seen from the list above this complexity is achieved first by the inclusion of rounded front vowels (/y:, ʏ, ø:, œ/) and second by the nearly complete arrangement of vowels in pairs slightly differing in quality and clearly in quantity. Whether this pairing is primarily based on tenseness [9, 14] or the durational difference [6, 18, 19] is still under discussion.

In addition, Standard German – at least on the phonetic level – also employs two schwa-like vowels (“reduction-vowels”) that cannot occur under word-stress and are usually transcribed as [ə] and [ɐ]. [ɐ] is mostly interpreted as a phonetic surface realization of underlying /ər/ or of /r/ in the coda after long vowels while a phonemic status is given to /ə/, e.g. [5, 10, 15], whereas others plead for a non-phonemic status of [ə], e.g. [2, 8, 14]. In nominal and verbal suffixes /ə/ is often affected by elision processes [6, 10] whereas it is always

preserved in verbal prefixes. In the present study an acoustic analysis of the realization of schwa in /Cə/-prefixes by Northern Standard German (NSG) and Austrian Standard German (ASG) speakers is undertaken. The investigation is based on the fact that pronunciation dictionaries [1, 5] as well as experimental studies (e.g. [18]) assume phonetic [ə] with some context-dependent variation in these positions for NSG, whereas ASG is reported to show [ɛ] ([1]), [e] ([12]) or [e<sup>ɔ</sup>] ([4]) instead.

## 2. ACOUSTIC ANALYSIS I: PROFESSIONAL SPEAKERS

To study schwa production in a highly elaborated Standard Pronunciation of German the realization of schwas in verbal <be-> and <ge-> prefixes spoken by TV news speakers was investigated.

### 2.1. Material and method

Public TV news broadcastings of the “Tagesschau” by the Northern German Broadcasting Corporation (NDR) in Hamburg, Germany were used as the database for NSG, “Zeit im Bild” news transmissions by the Austrian Broadcasting Corporation (ORF) in Vienna, Austria as database for ASG.

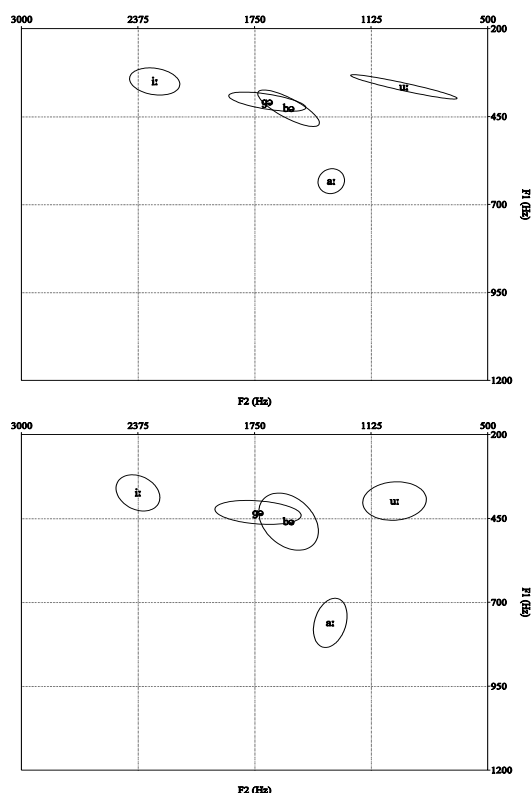
Two news broadcastings spoken by a male and two spoken by a female speaker were recorded for each of both German varieties by means of a two-channel VHS video-recorder with separate audio tracks. The data were digitized (16 bit resolution, 22050 Hz sampling rate). Vowels were segmented and labeled with the PRAAT phonetic analysis software [3] along wave form and time-aligned broadband spectrograms (Hanning window band-pass filtered between 60 and 5500 Hz and displayed at a dynamic level of 45 dB). First, vowel durations were measured as the interval between start and end of the voiced part of F2. Second, formants were measured by means of an LPC analysis (10 coefficients, 25 ms analysis window in 5 ms steps with a pre-emphasis of 6 dB per octave above 50 Hz) on the signal that was

down-sampled to 11025 Hz for female and to 9200 Hz for male speakers. F1, F2 and F3 frequencies were determined as the mean formant frequencies between the 40% and 60% points of the duration of each vowel.

## 2.2. Results

The analysis is based on 180 [ə] utterances (NSG: n=95; ASG: n=85). The F1/F2-plots ( $1\sigma$ -ellipses) of the [ə] realizations by the NSG and ASG news speakers are presented in Figs. 1 and 2 separately for male and female voices and for [g]- and [b]-environments. The data of the point vowels [i:], [a:] and [u:] are included to localize each speaker's vowel space.

**Figure 1:** F1/F2-plots for schwa realizations and point vowels ( $1\sigma$ -ellipses) of NSG news speakers (*above: male speaker – below: female speaker*).

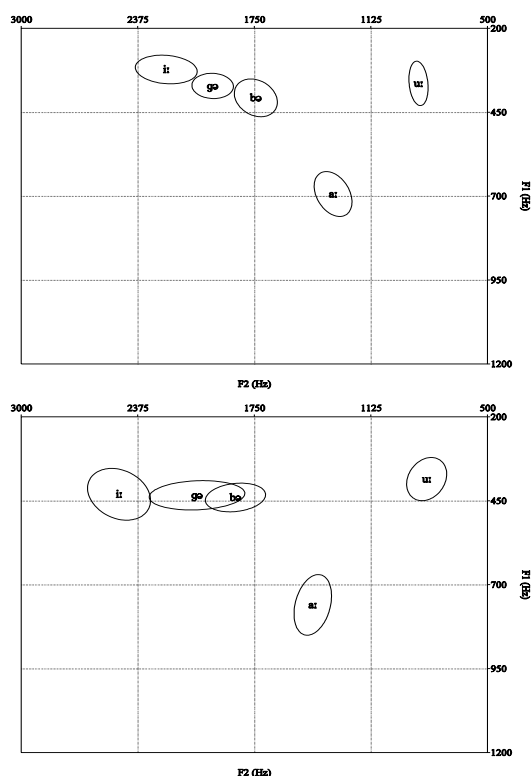


Due to anatomic reasons (vocal tract length differences) female vowel spaces are larger than male ones caused by the higher formant values in female speech. Firstly, it can be seen that in all cases F1 of [ə] is lower than usually calculated for an acoustic schwa (500 Hz for male and 600 Hz for female voices). Secondly, a clear context effect is visible in that F2 is higher in the <ge-> than in the <be-> context. For NSG speakers F2 is in the range of an acoustic schwa (1500 Hz for male and

1800 Hz for female voices), although the mean value for the male news speaker is slightly higher than expected (1684 Hz in [g]- and 1569 Hz in [b]-context). In general, both speakers show a greater variation in the realization of [ə] than in point vowels.

For the ASG news speakers the effect of a low F1 and the context effect re-occur. But opposed to NSG the F2 values for both ASG speakers are higher (approximately +200 Hz for the male and +300 Hz for the female speaker), thus nearly approaching the point vowel [i:]. Additionally, the variability in the schwa productions seems to be lower. F3 values are higher for ASG than for NSG.

**Figure 2:** F1/F2-plots for schwa realizations and point vowels ( $1\sigma$ -ellipses) of ASG news speakers (*above: male speaker – below: female speaker*).



## 2.3. Discussion

The results of the acoustic analysis show common as well as different behavior effects for NSG and ASG news speakers.

The low F1 values may be caused by the stop context that leads to a smaller jaw opening (yielding an increase of vowel height). The context effect (lower F2 in [b]-environment) can be interpreted as an acoustic consequence of co-articulatory lip-rounding after [b] which results in a lowering of F2.

The fronting of “schwa” by ASG news speakers corresponds to the literature reports that ASG prefers [e]-like realizations instead of [ə].

### 3. ACOUSTIC ANALYSIS II: EDUCATED NON-PROFESSIONAL SPEAKERS

Non-professional speakers of NSG and ASG served as a control group. (All of them were linguistics students, linguists or language-related professionals and had lived in their country of birth for their first 20 years.) These data were gathered from an existing database originally installed to investigate the realization of stressable full vowels in NSG and ASG [16]. Nevertheless, the data also contained schwa productions in <ge-> prefixes and could therefore be utilized for the present study.

#### 3.1. Material and method

16 speakers (4 females and 4 males of each variety) had produced all 15 stressable German vowels in a /bVp/ context embedded into a sentence frame “Ich habe /bVp/ gesagt” (“I said /bVp/”). The stimuli had been presented in a PowerPoint prompting sequence on a screen visible through the front pane of the recording chamber. After the production of one phrase the next prompt was delivered by the experimenter with a minimum interval of 3s.

The schwa realizations in <gesagt> were digitized, segmented and labeled as described above. Thus, 15 schwa utterances were obtained and analyzed for each speaker.

#### 3.2. Results

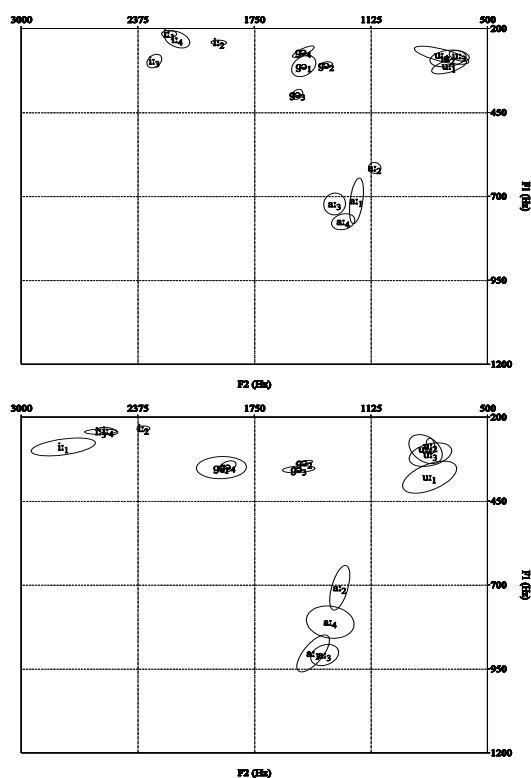
The F1/F2-plots for non-professional NSG and ASG speakers are given in Figs. 3 and 4 (4 speakers per plot). Due to the fact that reading of controlled speech items enforces clear articulation, the vowel spaces are in general widespread than in Analysis I, where fluent speech was explored.

While ASG speakers on the whole are consistent in the realization of their point vowels, NSG speaker show some considerable variation, especially in [i:]. Again, schwas are produced with low F1s in all cases.

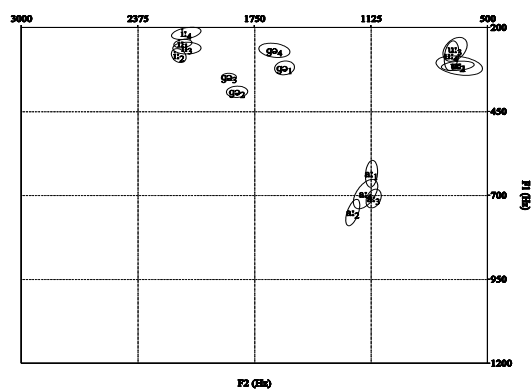
Concerning F2, NSG male schwas are consistently positioned around the 1500 Hz value, NSG female schwas in the 1800 Hz range for two of the speakers, the values are lower (about 1500 Hz) for both remaining ones. This result in part coincides with the F2 variation in [i:].

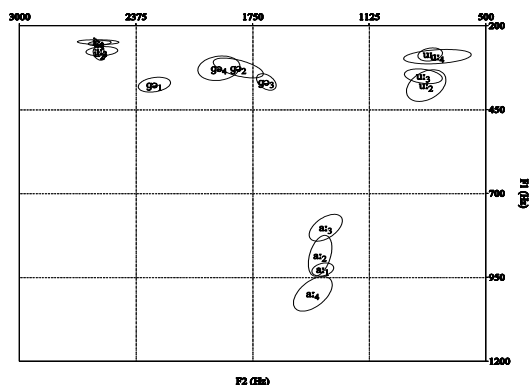
ASG speakers on the other hand show a schwa-intrinsic subgrouping: one group (2 males and 3 females) shows F2 values near acoustic schwa, the other group (2 males and 1 female) produce high front vowel-like F2s, as the ASG news speakers did in <ge-> prefixes. F3 measurements on ASG are on the same range as the NSG values, but vary across speakers.

**Figure 3:** F1/F2-plots for schwa realizations and point vowels (1 $\sigma$ -ellipses) of non-professional educated NSG speakers (*above: male speakers – below: female speakers*).



**Figure 4:** F1/F2-plots for schwa realizations and point vowels (1 $\sigma$ -ellipses) of non-professional educated ASG speakers (*above: male speakers – below: female speakers*).





### 3.3. Discussion

Non-professional NSG speakers in the main confirm the results obtained from the news speakers. ASG speakers instead show a speaker-dependent phonetic realization of the underlying /ə/ in <ge-> prefixes.

## 4. GENERAL DISCUSSION

Standard German exhibits a large vowel system with 15 full-vowel categories (stressable monophthongs, all being peripheral or nearly peripheral. In addition, there is one central vowel phoneme (unstressable reduction-vowel). In the present study the phonetic realization of this schwa sound in verbal prefixes is acoustically analyzed for two German varieties (Northern Standard German and Austrian Standard German).

According to the literature this vowel is in fact realized as a central vowel in verbal prefixes by NSG speakers (although with a lower F1 than expected), whether they are professional speakers or not. In ASG on the other hand, professional speakers realize a more fronted [e]-like vowel in this position. But it is revealed that non-professional ASG speaker differ inter-individually in either producing an [e]-like vowel as predicted or a central one, as NSG speakers do.

This result can be explained by assuming a partial influence of NSG (standard language in Germany) on ASG (standard language in Austria), i.e. some speakers rely more on the major variety (Germany) than on their own one (Austria). Whether this speaker-dependent variation reflects an ongoing sound shift in ASG as a whole has to remain an open question at present.

## 5. ACKNOWLEDGMENTS

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