

German Fricatives

In this project, I explored German fricatives, a sub-class of obstruents, as produced by a native German speaker from Chemnitz, Germany. This paper discusses three main topics regarding the data collected from the speaker. First, I talk about what I expected to find based on a sampling of the literature regarding fricatives in German, including what phonemes the language includes and my data in comparison to those expectations. Second, I discuss important allophonic alternation of palatal and velar fricatives, which are represented in my data as predicted. Last, I discuss a phonemic/allophonic relationship that the literature was not coherent about, initial /r/, and the phonetic realizations of that /r/ in my data.

The literature on German is conclusive about seven distinct fricative phonemes: labiodental /f/ and /v/, alveolar /s/ and /z/, post-alveolar /ʃ/ and /χ/, and glottal /h/. Though each of these is considered distinctive and not allophonic, some sounds occur only in certain environments. Namely, there is a fortition rule in German such that voiced obstruents lose voicing when in final position; in other words, the phonemic opposition is neutralized in this phonetic environment (Benware 1986: 22-27, 64-65). Thus, no voiced sounds will occur word-finally; so, the voiced /v/, /z/, and /χ/ are represented only initially and medially in my word list. Additionally, the voiced post-alveolar fricative /χ/ occurs only in borrowed words (often from French), so I did not attempt to find minimal pairs of it and other sounds.

My data exhibit each of these seven sounds with typical fricative characteristics: high-frequency intensity compared to other obstruents or vowels, decreasing frequency of high intensity as articulation moves farther back in the oral cavity, and visible formant transitions out of and into flanking vowels - particularly the "velar pinch" evident in velar fricatives where the F3 locus is relatively high and the F2 locus is relatively low. For the most part these were as

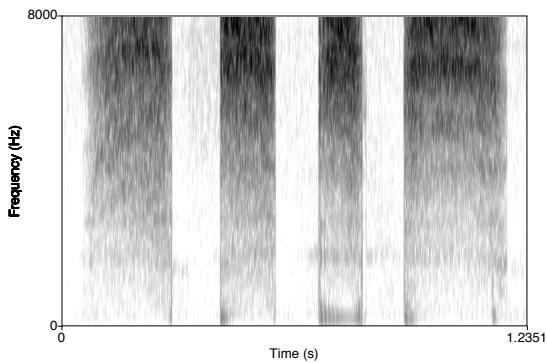
expected, though in a few instances, the speaker produced voiceless fricatives where I expected voicing to be present. This was not entirely surprising, given that research on German is ambivalent (in my sources) as to whether there is a categorical qualitative phonation differentiation in obstruents. For the voiceless and voiced labiodental, alveolar, and post-alveolar sounds, some authors describe the primary difference between pairs at the same point of articulation as between *fortis* and *lenis*, rather than voiceless and voiced. That is, the distinguishing feature between the phonemes is taken to be the amount of respiratory energy used to produce airflow, instead of the activity of the vocal cords. In these cases, what are typically classified as "voiced" fricatives in German are actually considered "lenis," and voicing may or may not be present in a lenis segment (Benware 1986). Because of the discrepancies in the literature, for my project I elicited only what were considered "voiced" fricatives, without attempting to elicit both "voiced" and "voiceless" lenis fricatives; this is consistent with the approach that most authors seem to take, which classifies by phonation rather than respiratory energy (Kohler 1990: 48-49; Ladefoged & Maddieson 1996: 95-99; Moulton 1962: 21-23).

While my speaker's tokens of voiceless fricatives were as expected, several that I anticipated to be voiced were in fact produced without voicing. Namely, the speaker's production of *Satz*, where initial *S* is generally voiced [z] (according to the literature, which indicates that voiceless alveolar fricatives rarely occur word-initially), included a voiceless initial alveolar fricative. At first it was unclear whether this was a lenis voiceless or a fortis voiceless fricative. To try to determine which was the case, I took the initial alveolar in *Satz* and compared it to the medial voiceless and voiced alveolars in *hasse* ([s]) and *reisen* ([z]). (I did not include a word with the intended elicitation being voiceless initial [s], because the speaker objected to the single word in any of the literature (*Satin*) that included initial voiceless [s], saying that it would

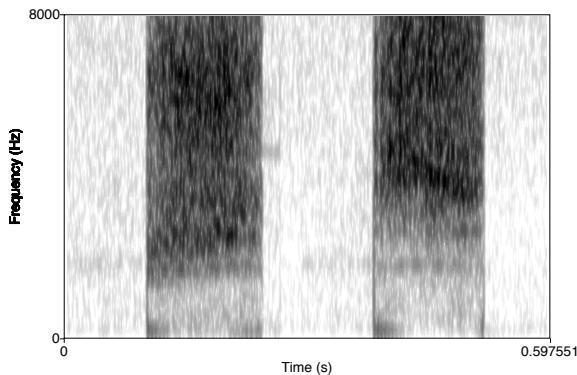
be no different from *Satz*. It is especially curious, then, that his articulation of initial *s* did not include voicing.)

As Fig. 1 shows, the spectrogram for *Satz* shows no voicing (there is no low-frequency intensity corresponding to a "voice bar"), yet it does have less intensity throughout its duration than does the medial [s] of *hasse*, which is also characteristic of voiced fricatives as compared to voiceless. And, its intensity follows a similar track as the voiced alveolar [z] in *reisen*. It also has slightly lower intensity than the final voiceless [s] in *Reis*. This may suggest that this is a lenis fricative, which most authors would lump into the category with voiced fricatives; however, I do not have a voiced alveolar fricative in initial position with which to compare.

Fig. 1: [s] *Satz* [s] *hasse* [z] *Reisen* [s] *Reis*



A similar issue arose with the voiced post-alveolar fricative, which the speaker produced without voicing in *Rage*, as shown below in Fig. 2. Note that this medial fricative has a spectrogram almost precisely similar to the medial voiceless [ʃ] in *Rauschen*. He does have a voiced post-alveolar fricative initially in *Jalousie*; however, he commented that in casual everyday speech, he would likely have pronounced it as de-voiced. Although I can't make generalizations based on this data, it seems that my speaker does not produce voiced alveolar or post-alveolar fricatives consistently.

Fig. 2: [ß] Rauschen [ß] Rage

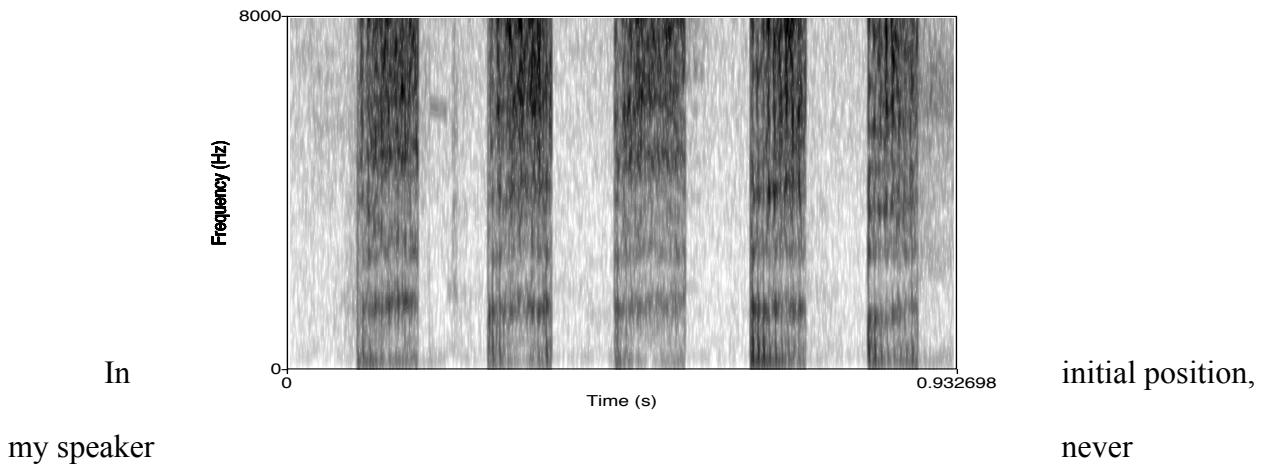
In addition to the seven fricatives mentioned above, German has a voiceless palatal and voiceless velar fricative that are in complementary distribution. In the literature regarding German phonetics and phonology, the phoneme is usually taken to be the voiceless velar fricative /χ/, and the allophone is the palatal [ç].¹ The palatal occurs following front vowels and consonants, whereas the velar occurs following back vowels. According to the literature, the velar also does not occur in initial position, though in my data it does occur in what seems to be a variant of /r/ (see discussion below). Hence, the speaker produces the palatal in *Chemie* where it is initial (despite the voiceless palatal being rare initially, according to Benware [41]), and *reichen* and *reich* where it follows a front vowel; he produces the velar in *rauchen* and *Rauch*, where it follows a back vowel.

Finally, the most complex aspect of German fricatives in this project was regarding variation in the sound represented in orthography by *r*, and according to the literature these are variants of the phoneme alveolar trill /r/. Kohler reports that the voiced uvular fricative /ʁ/ is a phoneme and can be heard in words such as *Rasse*; however, the other sources I consulted claimed that the voiced uvular fricative is just one of several possible variants for the German

¹ cf. Kohler. Moulton, however, considers the voiceless palatal and velar fricatives to *both* be phonemes (pp. 21-23).

/r/, not a phoneme itself (thus, I did not attempt to elicit it as a distinct phoneme). Other possible variants discussed are the alveolar trill and voiced velar fricative (Benware 1986: 44-45 and 68-9; Russ 1994: 147-149). Benware claims that variation is not phonologically conditioned for the most part and depends instead on dialect differences. Moulton, however, offers a lengthy discussion of /r/, where he says that when prevocalic it is generally a voiced uvular fricative [E̥], but sometimes an alveolar trill [r]. He also discusses alternation in postvocalic non-prevocalic contexts, but I did not have any examples of this context in my data, so I will not discuss it here. I prepared my word list with several initial and medial /r/ tokens in order to explore what my speaker produced in these instances; however, by coincidence, my list also included many more initial /r/ words, so I was able to look at 15 tokens of initial /r/ in a five different following vowel contexts ([o][a][ḁ][ɔ̥][ḁ]), along with five tokens of medial /r/. Each of the medial /r/ tokens was produced as a velar, and while *fahren* and *Waren* are voiceless [x], *irre* and *führe* are voiced [ɔ̥]. The differences are apparent in voice bars in the spectrograms of the latter two, as well as a strong perceptual difference. The medial /r/ context spectrograms (for *fahren1*, *fahren2*, *Waren*, *irre*, *führe*) are shown below in Fig. 3.

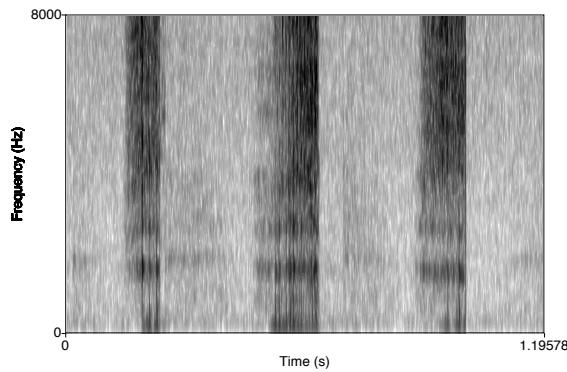
Fig. 3: [x] *fahren* [x] *fahren* [x] *Waren* [ɔ̥] *irre* [ɔ̥] *führe*



produced the alveolar trill [r] (or a trill of any sort), nor did he produce a uvular [ɛ̄]; both of these were variants said to be common in the literature. Rather, he always produced a velar fricative, though distinguishing between whether these were voiced or voiceless was often difficult. Some difficulties arose in determining voice quality via my own perception, and there was also heavy seeming coarticulation from preceding vowels often affecting phonation mid-segment. Voiced fricatives usually have either a low-frequency F1 "voice bar," less intensity than their voiceless counterparts, and/or visible vertical striations indicating vocal fold vibration. This was not clearly evident in many of the sounds, even ones that often *sounded* voiced. This might have something to do with their being prevocalic, or it might be that the lenis/fortis distinction is more relevant here than phonation.

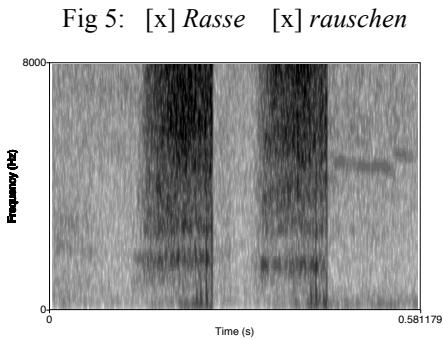
The words whose spectrograms *do* show a voice bar are shown below in Fig. 4. These include *reisen*, *reif*, and *Reis*. In these sounds, you can see the low-frequency voice bar as well as vertical striations, which are fairly constant throughout the fricative.

Fig. 4: [©] *reisen* [©] *reif* [©] *Reis*



In opposition to the above voiced fricatives, most realizations of initial /r/ were voiceless; however, there is wide variety in duration of friction, as well as the amount of voicing present within the fricative. That is, in most cases, the fricative began without voicing - which is clear

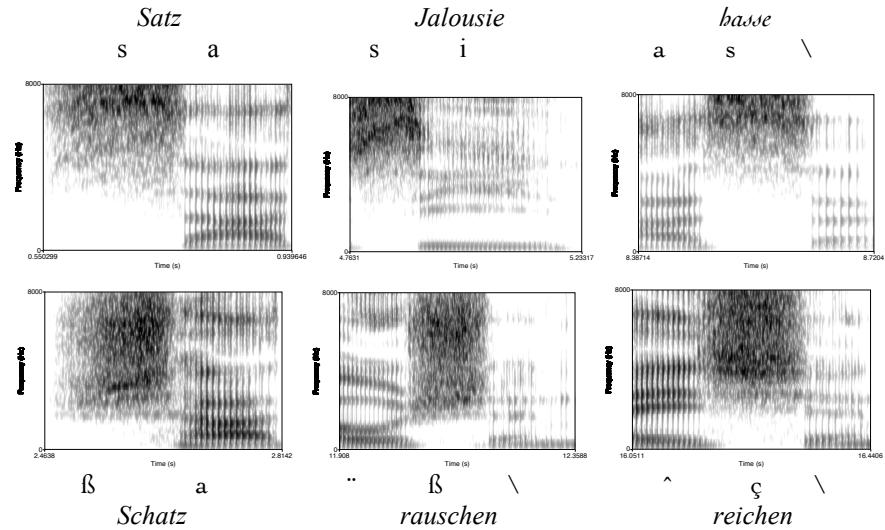
on the spectrographic information in that there is no low-frequency energy - yet some amount of voicing occurred within the latter part of the fricative, evident in the voice bar and vertical striations. For example, in *Rasse*, total duration of the fricative is about 111 ms, and the last 53 ms of it are with vocal cord vibration - more than half the total duration of the fricative. Nonetheless, the overall percept is voiceless. We might attribute this to coarticulation due to anticipatory voicing for the following vowel. By way of contrast, the initial [x] in *rauschen* is about 128 ms, but it is only voiced for about 26 ms. This is just one example of the variety in phonation, shown below in Fig. 5.



The only initial /r/ in which at least *some* anticipatory voicing did not happen is *rot*, where there is absolutely no voicing preceding the vowel; the difference between it and other tokens is particularly striking and may be compounded by an articulation further front than many of the other velars, so that it has none of the trilling that can sometimes occur in velars farther back (or in uvulars). The lack of voicing may in fact be an indication of articulation further front, when we consider that the fricatives produced further front seem more resistant to coarticulation from voicing of the following vowel. That is, initial [s] in *Satz* (which I had in fact expected to be voiced) and [ʃ] in *Schatz*, and medial [s] in *Jalousie* and *hasse*, for instance, show almost no voicing at all, as shown in Fig. 6 below. This is the case with other tokens of the voiceless alveolar and post-alveolar fricatives; although the palatal [ç] shows a fair amount of

voicing in transitions into and out of it in, for example, *reichen*. So, the tendency for voicing to happen sooner in velar fricatives may be related to proximity to the glottis during articulation; where here, voicing starts sooner in the fricative the closer it is to the glottis. Or, in general, a fricative will be more resistant to coarticulation involving phonation if it is farther from the glottis in production. This makes sense considering that back closures cause a faster pressure drop above the glottis than more front closures (because air escapes the oral cavity sooner), which enables vocal cord vibration.

Fig. 6



In sum, I have discussed three aspects of German fricatives as I elicited them from a native German speaker. First, the speaker's realizations of seven of the fricative phonemes were fairly regular, though I found that he did not produce voiced alveolar or post-alveolar fricatives in a few expected places. Second, the speaker's alternation between the voiceless palatal and the voiceless velar fricative was as expected, demonstrating the allophonic variation oft-discussed in the German phonemics literature. Third, in exploring the phoneme /r/, I found that the speaker

only produced two variants out of at least twice that many possibilities, both of which were velar fricatives (the voiced and voiceless). His consistent use of the voiceless velar in the initial /r/ position is particularly interesting, given that none of the sources I have listed [x] as a sound occurring initially, even as a variant of /r/. A follow-up project would take this as its main focal point, systematically eliciting a variety of phonetic contexts for /r/ to determine whether the speaker does produce [r] or [ɛ̄] in contexts other than what I elicited, or whether his dialect/idolect consistently realizes [x] or [ɔ̄].

Appendix I: Chart of Discussed German Sounds: Fricatives and Alveolar trill

	Labiodental		Alveolar		Post-alveolar		Palatal		Velar		Uvular		Glottal	
fricative	f	v	s	z	ß	□	ç		x	©		ë	h	
trill			r											

Appendix II: List of German Words Used for Elicitation

Note: Transcriptions are based on speaker's production as named "withoutglossfromoriginal" on the accompanying CD. This corresponds to the second time through on the accompanying backup tape.

I. As read by speaker, illustrating near-minimal pairs:

	<u>Transcription</u>	<u>Orthography</u>	<u>Gloss</u>
<i>Initial:</i>	[«fa:x\n]	fahren	'to drive'
	[«va:x\n]	Waren	'goods'
	[«sats]	Satz	'sentence'
	[«ßats]	Schatz	'treasure'
	[□alo«si]	Jalousie	'jealousy' (Fr.)
	[ç^«mi]	Chemie	'chemistry'
	[«has]	hasse	'to hate'
	[«xo:t']	rot	'red'
	[«xas]	Rasse	'race/breed'
	[«xa^x\n]	rauchen	'to smoke'
<i>Medial:</i>	[«x^p`]	Rippe	'rib'
	[«hy:f]	Höfe	'yards'
	[«ly:v]	Löwe	'lion'
	[«xa^s\n]	rei□en	'to tear'
	[«©a^z\n]	reisen	'to travel'
	[«xa^ß\n]	rauschen	'to rustle'
	[«xa:ß]	Rage	'rage'
	[«xa^x\n]	rauchen	'to smoke'
	[«xa^ç]	reichen	'to pass'
	[«fa:x\n]	fahren	'to drive'
<i>Final:</i>	[«÷^x]	irre	'crazy'
	[«fØox\]	füre	'to lead'
	[«©a^f]	reif	'ripe'
	[«©a^s]	Reis	'rice'
	[«xa^ß]	Rausch	'intoxication'
<i>II. By sound:</i>	[«xa^x]	Rauch	'smoke'
	[«xa^ç]	reich	'rich'

II. By sound:

/f/		
initial:[«fa:x\n]	fahren	'to drive'
	füre	'to lead'
medial: [«hy:f]	Höfe	'yards'

final: [«◎a^f] reif 'ripe'

/v/

initial:[«va:x\n]	Waren	'goods'
medial: [«ly:v]	Löwe	'lion'
final: does not occur		

/s/

initial:[«sats]	Satz	'sentence'
medial: [□alo«si]	Jalousie	'jealousy' (Fr.)
[«has]	hasse	'to hate'
[«xas]	Rasse	'race/breed'
[«xa^s\n]	rei□en	'to tear'
final: [«ßats]	Schatz	'treasure'
[«◎a^s]	Reis	'rice'

/z/

initial:does not occur in my data		
medial: [«◎a^z\n]	reisen	'to travel'
final: does not occur		

/ß/

initial:[«ßats]	Schatz	'treasure'
medial: [«xa^ß\n]	rauschen	'to rustle'
[«xa:ß]	Rage	'rage'
final: [«xa^ß]	Rausch	'intoxication'

/□/

initial:[□alo«si]	Jalousie	'jealousy' (Fr.)
medial: does not occur in my data		
final: does not occur		

/x/

initial:[«xo:t']	rot	'red'
[«xas]	Rasse	'race/breed'
[«xa^x\n]	rauchen	'to smoke'
[«x^p']	Rippe	'rib'
[«xa^s\n]	rei□en	'to tear'
[«xa^ß\n]	rauschen	'to rustle'
[«xa:ß]	Rage	'rage'
[«xa^ß]	Rausch	'intoxication'
[«xa^x]	Rauch	'smoke'
[«xa^ç]	reich	'rich'
[«xa^ç\n]	reichen	'to pass'

medial:	[«xa:̥x̥n]	rauchen	'to smoke'
	[«fa:x̥n]	fahren	'to drive'
	[«va:x̥n]	Waren	'goods'
final:	[«xa:̥x̥]	Rauch	'smoke'

[ç]

initial:	[ç^«mi]	Chemie	'chemistry'
medial:	[«xa:̥ç̥n]	reichen	'to pass'
final:	[«xa:̥ç̥]	reich	'rich'

[ɔ̥]

initial:	[«ɔ̥a:̥z̥n]	reisen	'to travel'
	[«ɔ̥a:̥f̥]	reif	'ripe'
	[«ɔ̥a:̥s̥]	Reis	'rice'
medial:	[«÷̥x̥]	irre	'crazy'
	[«f̥Øøx̥]	führe	'to lead'
final:	does not occur		

/h/

initial:	[«has̥]	hasse	'to hate'
	[«hy:f̥]	Höfe	'yards'
medial:	does not occur		
final:	does not occur		

Appendix III: References

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