Voicing Contrasts in German Consonant Clusters

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1 Introduction

As we saw in the Dutch problem set, fricatives can show different voicing neutralization patterns from stops. This squib explores voicing neutralization patterns for fricatives in German. In particular, it appears that sibilant fricatives [s-z] show different patterns from [f-v] in German. Here I will flesh out the voicing paradigm for each of the fricatives and propose an analysis to explain the facts.

All of the data come from German audiobooks[1] and were analyzed using Praat. Some aspects of the paradigm that I present have already been discovered by other authors. For consistency, everything I present is the result of my own observations based on the recordings that I have. I will note if/when the results differ from accepted results (to the best of my knowledge).

2 Voiced v. Voiceless Fricatives

Table 1 shows a preliminary typology for voicing contrasts in German[2]. We see that [s-z] contrast in fewer contexts than [f-v].

	V_O a**s**pa vs. a**z**pa	V_# a**s** vs. a**z**	O_V ap**s**a vs. ab**z**a	#_V **s**a vs. **z**a	V_V a**s**a vs. a**z**a
s-z	no	no	no(?)	no	yes
f-v	no	no	(yes)	yes	yes

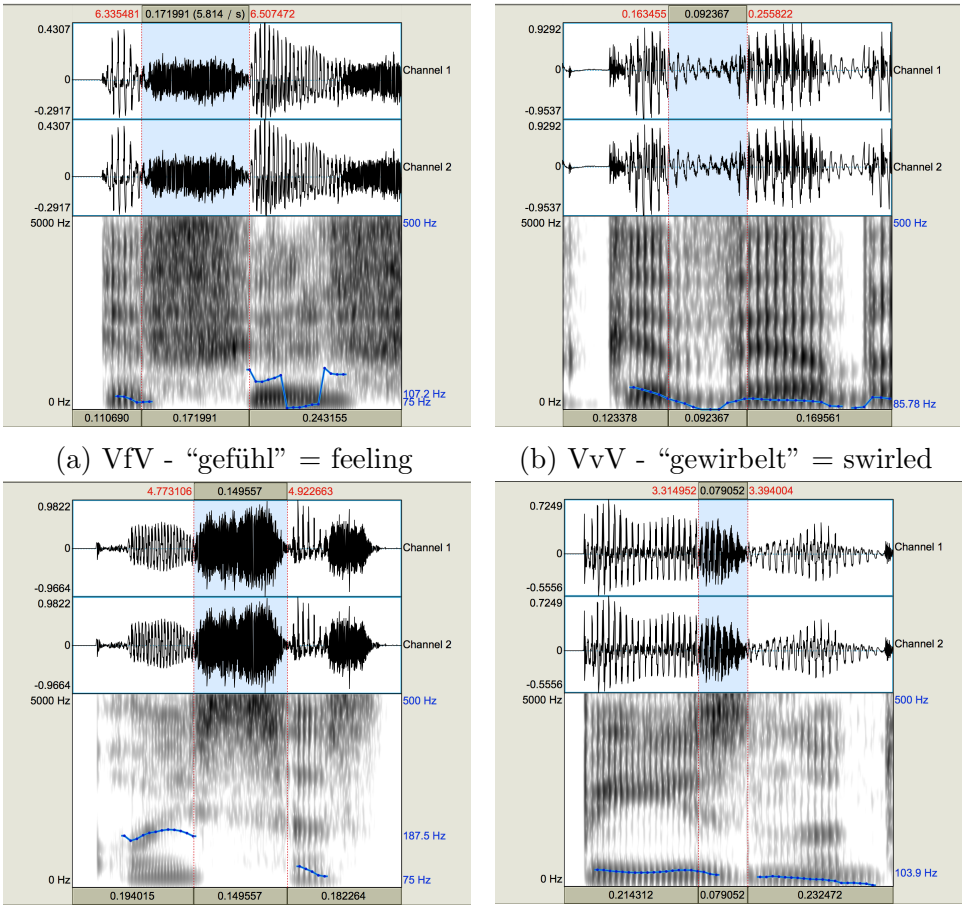
Table 1: A preliminary typology for fricative contrasts as reported in a 2013 handout by Flemming.

My goal for this paper is to check for contrasts in O_V contexts and investigate fricative voicing patterns in fricative-liquid clusters as well. Ultimately, I will propose

[1]The audiobooks in question are the seven Harry Potter books narrated in German by Rufus Beck.

[2]Note: V = vowel, O = obstruent, Z = fricative, R = liquid

an analysis for voicing neutralization where it occurs. Since I am relying on waveforms and spectrograms to discover voicing patterns, I begin by explaining how I deduce from Praat whether a fricative is voiced. Below are some figures showing German fricatives in intervocalic contexts, where they all contrast. The blue portions of the waveforms are the fricatives in question (and later the shaded regions will contain the relevant consonant clusters).



(a) VfV - "gefühl" = feeling

(b) VvV - "gewirbelt" = swirled

(c) VsV - "äusserst" = extremely

(d) VzV - "besen" = broom

Figure 1: Intervocalic: /f/-/v/&/s/-/z/

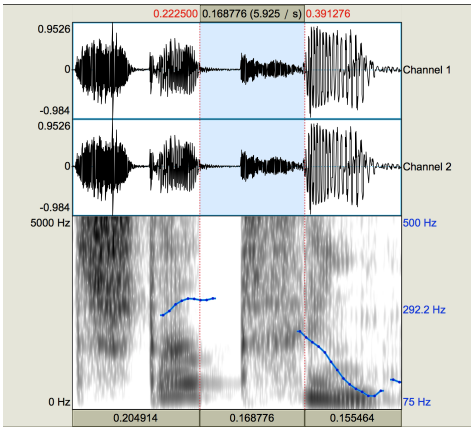
We see that for [f-v], the distinction between voiced and voiceless is quite clear. Voiceless [f] is a very noisy signal while voiced [v] has clear voicing bars in the spectrogram and periodic behavior in the waveform[3]. The distinction for the sibilant fricatives is less clear because both emit noisy, high frequency signals. Voicing bars are somewhat discernible for [z], but the main difference is that [s] is much higher intensity than [z]. There also appears to be a length contrast between voiced and voiceless fricatives, namely voiceless fricatives are usually longer than voiced ones.

[3]German orthography writes the [v] sound as 'w', [s] as 'ss', and [z] as 's'.

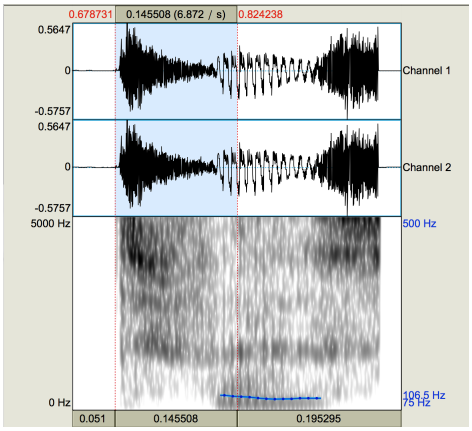
3 O_V Contexts

3.1 Stop-Fricative Clusters

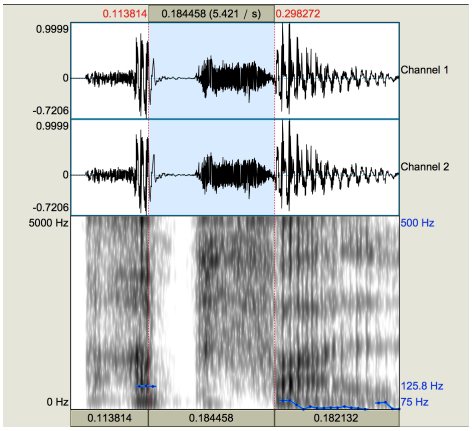
I began by looking for stop-fricative clusters with both voiced and voiceless preceding stops. Figure 2 shows some examples of clusters that I found, highlighted in blue. It appears that [f-v] contrast after both voiced and voiceless stops. Furthermore, voiceless [f] causes the preceding stop to devoice, but voiced [v] does not cause the preceding stop to voice[4].



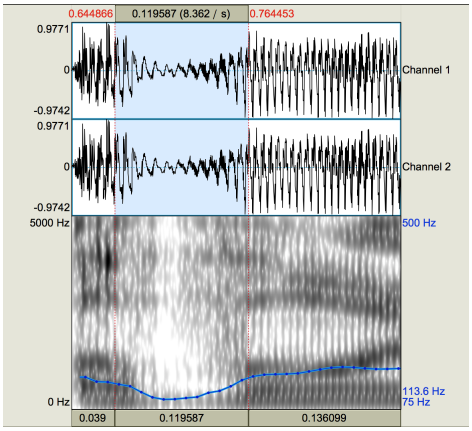
(a) /tf/ → [tf] - "stattfinden" = to take place



(b) /tv/ → [tv] - "etwas (emphatic)" = something



(c) /bf/ → [pf] - "abfall" = waste

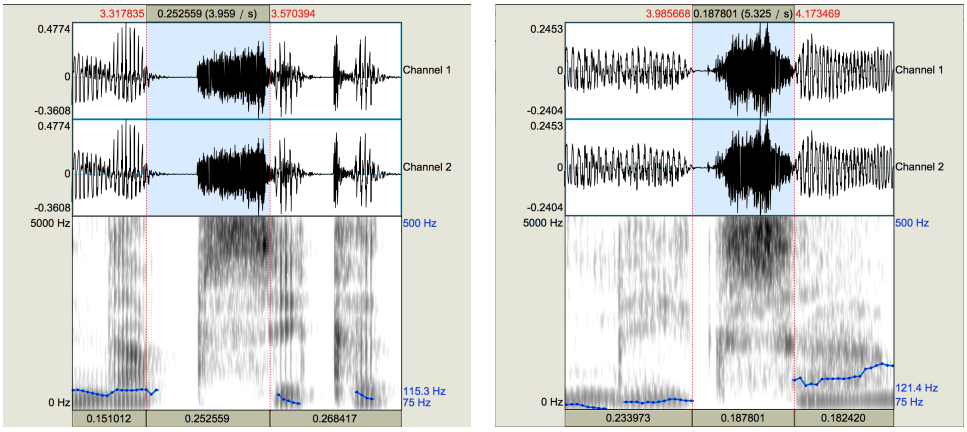


(d) /bv/ → [bv] - "obwohl" = though

Figure 2: /t/&/b/-(/f/or/v/)

[4](2b) shows the word 'etwas' spoken emphatically because fast speech was very difficult to analyze. Due to the emphasis, the [t] was aspirated more than it normally would be, accounting for the amount of noise we see. This is somewhat misleading because it could cause us to think that the noise is due to a voiceless [f], when actually it is the [t]. The [v] begins later on, blending into the following vowel.

On the other hand, sibilants always devoice in clusters, and cause the preceding stop to devoice as well.



(a) /bz/ → [ps] - "hinabsickerte" = seeped

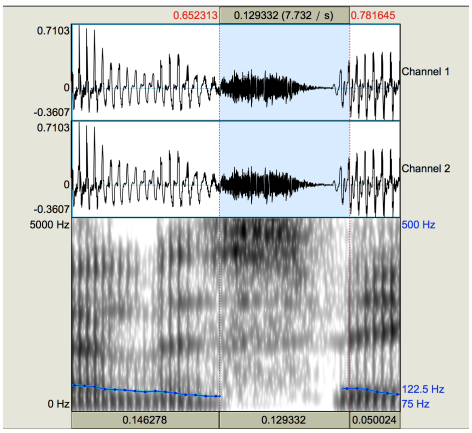
(b) /gz/ → [ks] - "unbiegsam" = inflexible

Figure 3: /b/&/g/-(/s/or/z/)

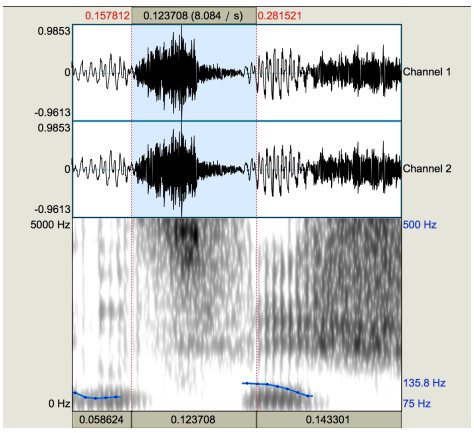
I am making a number of assumptions about the underlying representations of these clusters. First, I am assuming that the underlying representation of the prefix *ab-* is true to the orthography. I think this is a reasonable assumption to make, however the reasoning behind this assumption is perhaps somewhat complicated and incomplete. I will discuss this more in the appendix. I also assume that the underlying form of the suffix *-sam* is [zam]. I think this because it appears as [zam] when appended to words that end in vowels such as *grau* to make *grau/z/am* (= 'gruesome'). Finally, I assume that the initial sibilant in the root form of the word *sickern* (*/z/ickern*) appears faithfully in isolation, yielding an underlying representation [bz] when combining with *hinab* (→ *hina/bz/ickern*).

3.2 Fricative-Fricative Clusters

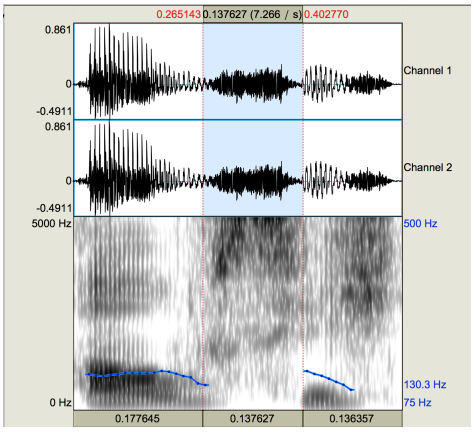
The results for fricative-fricative clusters are somewhat less clear. Since none of the fricatives contrast for voicing as the first consonant of a cluster, it is only possible to test for [sf], [sv], [fs], and [fz]. Both [sf] and [fs] are unsurprisingly attested. On the other hand, we do not see [fz] (as seen in (4b)), but it is unclear if [sv] is possible. The transition period between the cluster and the vowel is sufficiently small that it is difficult to discern periodicity. Since there is a relatively smooth transition though, I am inclined to think that it is not entirely voiceless. Furthermore, playing the cluster right at the transition point between the consonants sounds more like [v] than [f]. This sounds promising but I am hesitant to call it conclusive evidence so I will report the results as [s?] from now on.



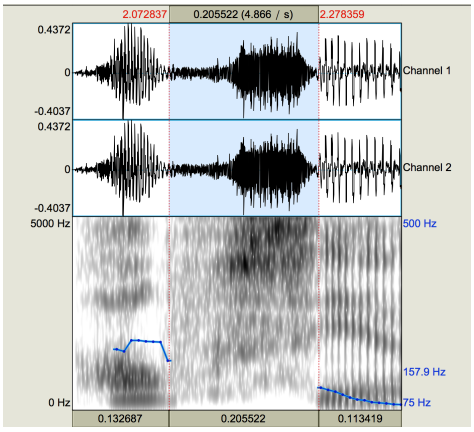
(a) /sv/ → [s?] - "keineswegs" = by no means



(b) /sv/ → [s?] - "inzwischen" = in the meantime



(c) /fz/ → [fs] - "aufsicht" = supervision



(d) /fz/ → [fs] - "aufseher" = supervisor

Figure 4: /s/&/f/ - /s/or/z/or/f/or/v/

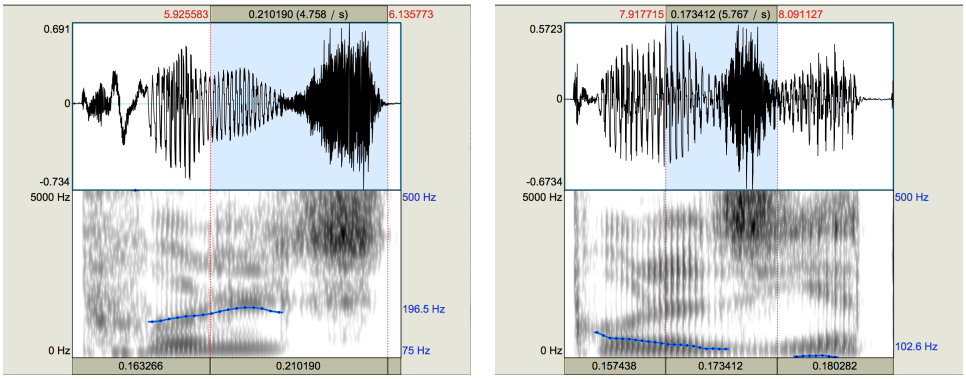
In summary we see that sibilants universally devoice in obstruent clusters, while [f-v] contrast in voicing in stop-fricative clusters and potentially fricative-fricative clusters as well.

4 R_V Contexts

It is clearly audible (and unsurprising) that [f-v] contrast after liquids so I did not feel the need to present those data here[5]. In looking for words with liquid-sibilant clusters however, I discovered a lack of true [ls] clusters. I tried to force [ls] clusters by taking words that I thought should have an underlying [lz] cluster and making the cluster show up word finally so the [z] would devoice. For example the word that

[5]Some examples of this are *he[lf]en* = 'to help' and *he[lv]ach* = 'wide awake'.

means ‘to pulse’ is *pu[lz]ieren*. The noun ‘pulse’ is spelled *Puls*, so I predicted that this would give me the cluster [ls]. However, it actually surfaced as *Pu[lts]* with an epenthetic [t].



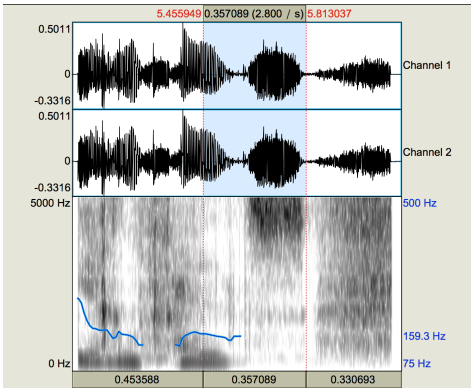
(a) /lz/ → [lts] - “puls” = pulse (b) /lz/ → [lz] - “pulsierte” = pulsed

Figure 5: /l/-(/s/or/z/)

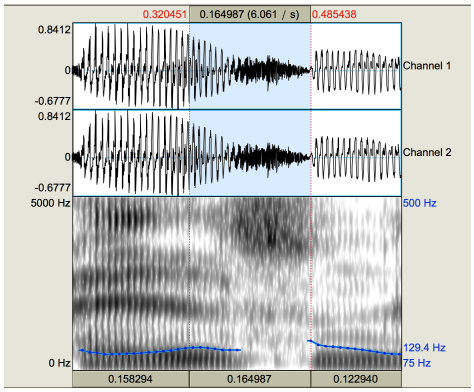
I also found other instances of this behavior, shown below in figure 6 with the word *Fels*. There is good evidence that the underlying representation of these clusters is really [lz] and not [lts], because there are words with underlying [lts] that remain faithful [lts] clusters when inflected. For example *Pe[lts]* = ‘fur’ becomes *Pe[lts]e* in the plural. Since the examples in figures 5 and 6 do not remain faithful to [lts] when inflected, I assume that they are really [lz] clusters that only become [lts] as the result of some phonological process.

There are multiple contexts in which [lz] should become [ls] and actually becomes [lts]. One of these contexts is when the root is inflected with the adjectival suffix [ig] (pronounced *ɪx* by most speakers). The voicing patterns that result from this suffix are somewhat complicated, but when it attaches to an obstruent that is part of a cluster, the obstruent devoices[6]. We see that in figure (6c), *felsig* is in fact realized as *fe[lts]ig*.

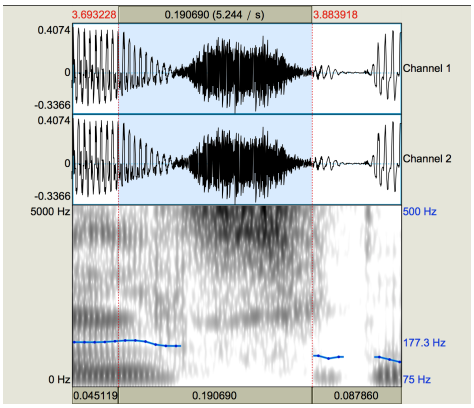
[6]This morpheme is interesting because when it itself is inflected for case/plural/gender/etc., it can have a different effect on the voicing patterns of the consonant it attaches to. I could probably write another squib on the morphophonology of German but the best I can do now is provide a few examples in the appendix.



(a) /lz/ → [lts] - "fels" = rock



(b) /lz/ → [lz] - "felsen" = rocks



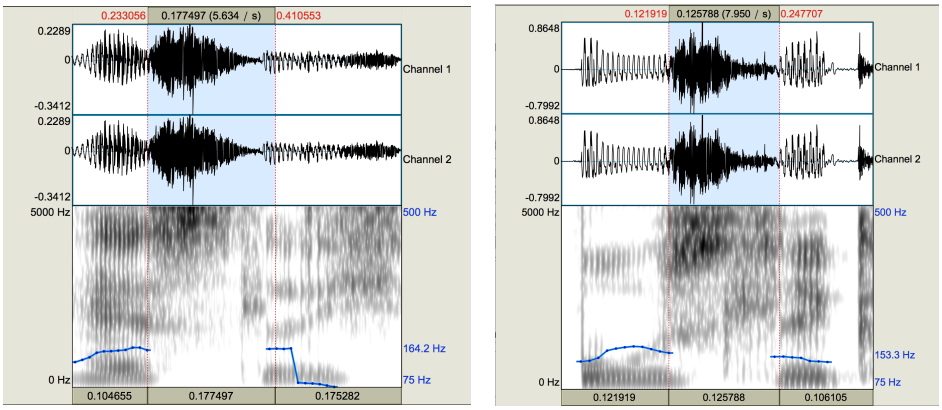
(c) /lz/ → [lts] - "felsig" = rocky

Figure 6: /l/-(/s/or/z/)

In summary, we see that both [f-v] and [s-z] contrast after liquids, with the additional fact that [ls] is realized with an epenthetic [t].

4.1 Brief Note on ZR Clusters

It is reported in (Beckman, Jessen and Ringen 2006) that [s-z] contrasts are permitted before liquids, although [z] may be optionally neutralized to voiceless. I found relatively few instances of these clusters, but all of the recordings that I found had voicing neutralization before [l]. Furthermore, it is my intuition that for words like *gruslig*, the sibilant can in fact be voiced as long as there is also an epenthetic vowel between [s] and [l]. This vowel occasionally appears in the orthography (google suggested two spellings for this word, one of which was *gruselig*).



(a) /sl/ → [sl] - "hässlich" = ugly (b) /zl/ → [sl] - "gruslig" = scary

Figure 7: (/s/or/z/)-/l/

5 Analysis

The below table summarizes the results thus far. In general, it seems that [f-v] contrast in all of the contexts (except maybe following [s]), while [s-z] contrasts are more often neutralized.

	UR	SR
SZ	bf	pf
	bv	bv
	tv	tv
	tf	tf
	bz	**ps**
	gz	**ks**

	UR	SR
ZZ	sf	sf
	sv	s?
	fs	fs
	fz	**fs**

	UR	SR
RZ	lf	lf
	lv	lv
	ls	**lts**
	lz	lz

Table 2: Summary of results

There are a number of facts we need to account for:

1. Voiced stops become voiceless stops before voiceless fricatives.
2. Voiceless stops do not become voiced stops before voiced fricatives.
3. Voiced sibilants do not appear after [-sonorant] consonants.
4. The cluster [ls] is realized with an epenthetic [t], yielding [lts].

To explain the first fact, I propose the following markedness and faithfulness constraints: $*$[αvoice,-son][-αvoice,-son], IDENT(voice) and IDENT(voice)/ONSET. $*$[αvoice,-son][-αvoice,-son] must be ranked above IDENT(voice) or we would always predict the

faithful candidate. We have no ranking argument between IDENT(voice)/ONSET and IDENT(voice) at this point.

/bf/	∗[αvoice,-son][-αvoice,-son]	IDENT(voice)/ONSET	IDENT(voice)
bf	∗!		
☺ **pf**			∗
bv		∗	∗!

This poses a problem for the second fact, namely that we predict voiceless stops to assimilate in voicing to a following voiced fricative, which is not the case.

/tv/	∗[αvoice,-son][-αvoice,-son]	IDENT(voice)/ONSET	IDENT(voice)
tv	∗!		
☹ **dv**			∗
tf		∗	∗!

To circumvent this, I propose to redefine IDENT constraints to favor specific values of a feature instead of just the feature. In this case, I propose IDENT(-voice), which is violated when an underlying voiceless consonant is realized as voiced, but not the other way around. This constraint, when ranked above our markedness constraint, predicts the correct result. We also now have a ranking argument for the two (+voice) faithfulness constraints. The context sensitive one must be ranked higher to prevent [tf] from surfacing.

/tv/	IDENT(-voice)	∗[αvoice,-son][-αvoice,-son]	IDENT(+voice)/ONSET	IDENT(+voice)
☺ **tv**		∗		
dv	∗!			
tf			∗	∗!

Now moving to fact number 3, I propose another markedness constraint banning [-sonorant][+sibilant,+voice] clusters: ∗[-sonorant][+sibilant,+voice]. I assume this constraint can be motivated by a combination of production and distinctiveness limitations. This constraint must be ranked above IDENT(+voice)/ONSET, and hence above the other markedness constraint. In the below tableaux I ignore the context free faithfulness constraint as it isn't active here.

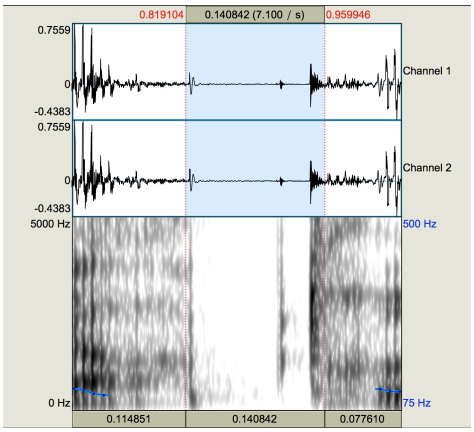
/bz/	∗[-sonorant][+sibilant,+voice]	∗[αvoice,-son][-αvoice,-son]	IDENT(+voice)/ONSET
bz	∗!		
bs		∗!	∗
☺ **ps**			∗

Finally, to explain fact number 4, I propose another markedness constraint on [ls] clusters: ∗[+cons,+son][+sibilant,-voice]. I believe this constraint to be motivated by production limitations. This constraint combined with a low ranked faithfulness constraint such as DEP(t) predicts the results that we see.

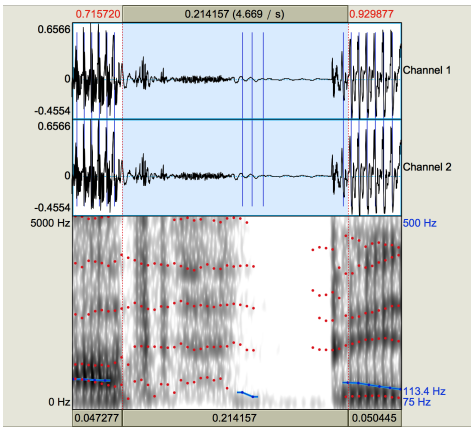
/ls/	IDENT(-voice)	∗[+cons,+son][+sibilant,-voice]	DEP(t)
ls		∗!	
lz	∗!		
☺ **lts**			∗

5.1 What about stops?

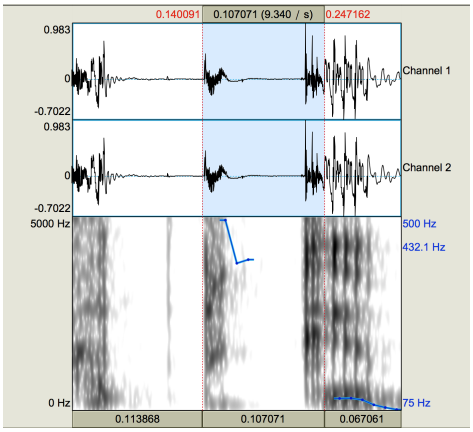
This analysis makes a prediction, namely that [f-v] behave the same way as stops. From this we expect to see voicing contrasts in stops before voiced stops. However, as Edward mentioned to me after my presentation, stop clusters in German have not been reported to behave this way. After looking at stop clusters in my data pool, I have discovered mixed results.



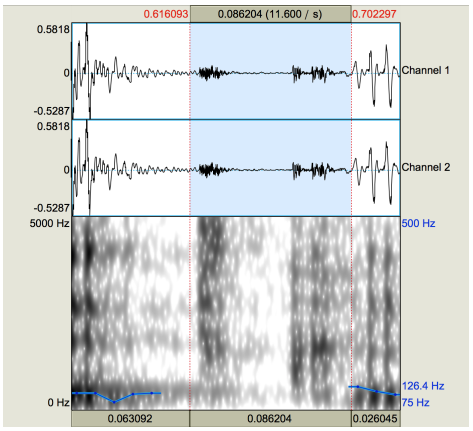
(a) /bd/ → [pt] - “abdrücke” = impressions



(b) /bb/ → [p^{h}b] - “abbilder” = images



(c) /bg/ → [pg] - “abgebildet” = shown



(d) /dg/ → [dg] - “erdgeschoss” = ground floor

Figure 8: Stop Clusters

It appears that voicing contrasts are possible before voiced stops (unless I have misanalyzed the data), which is interesting as it apparently contradicts the literature. However, not all stops appear to behave the same way. For instance (8a) shows us neutralization of [d] following [p]. I couldn't find any German words in which [d] remained voiced after either a voiced or voiceless stop. On the other hand, (8b-c) show us that [b] and [g] behave differently, as there are contrasts between [p-b] and [k-g] in those positions. I don't really know what to make of this at the moment. This could be a topic for future research.

6 Conclusion

To conclude, I have shown that [f-v] behave differently with regard to voicing neutralization than [s-z]. This is interesting, but also predicted if we consider distinctiveness as possible motivation for phonological processes. My data and analysis raise several questions about how voicing neutralization occurs more generally in German. In particular, it is unclear what morphophonological processes govern how affixes affect voicing neutralization. Furthermore, it is unclear if my analysis makes the right predictions for stop clusters, given that my data show different patterns than what is commonly attested in the literature.

Both Edward and Michael mentioned to me that German fricatives appear to behave much in the same way as Russian fricatives. It has been proposed for Russian that [v] is actually a partial approximant, rather than a true obstruent. If I were to obtain clearer results for stop clusters, I may be inclined to pursue such an analysis.

References

[1] Flemming, E., *Differences in the distribution of fricative and stop voicing contrasts*. 24.964 More Advanced Phonology, Handout 9, 2013.

[2] Gussenhoven, C. and Bremmer, R.H., *Voiced fricatives in Dutch: sources and present-day usuage*. *NOWELE* 2,55071, 1983.

[3] Beckman, Jessen and Ringen, *Phonetic Variation and Phonological Theory: German Fricative Voicing*. WCCFL Proceedings, 2006.

[4] Padgett, Jaye, *Russian voicing assimilation, final devoicing, and the problem of [v]*. UCSC, 2002.

A Word/Morpheme Inventory

If someone were to retest my results for other German speakers, here is a list of words with relevant consonant clusters that they might use.

SZ		ZZ		RZ	
abfall	waste	aufseher	supervisor	als	than
absichtlich	purposefully	deswegen	therefore	also	so
abwehr	defense	inzwischen	in between	fels(en)	rock(s)
antworten	to answer	keineswegs	by no means	felsig	rocky
beabsichtigen	to intend	ausflug	trip	felsbrucke	boulder
etwas	something	zwingen	to force	hals	neck
folgsam	obedient			puls	pulse
hinabsickern	to seep out/through			pulsieren	to pulse
irgendwelcher	whichever			wulstig	bulging
tatsachen	facts				
obwohl	even though				
quellen	sources				
schlagsahne	whipping cream				
schweigsam	taciturn				
stattfinden	to take place				
überbleibsel	survival				
unbiegsam	inflexible				

The affixes that I found most useful were: -sam, -ig, ab-. I showed previously that the underlying representation of *-sam* was -[z]am. The other two interact with voicing patterns in ways that are less clear. When *-ig* attaches to roots that end in consonants, the voicing patterns of those consonants vary. Below are two examples. For *hochnäs-ig* only [s] is possible, but for *ries-ig* I think [z] is more commonly used (though some speakers might partially or fully devoice). I haven't done a full-scale search for all words [-ig] could attach to but I think the length of the preceding vowel is relevant to whether the consonant devoices. Whether or not the [g] devoices is I think also relevant (recall it is pronounced [x] word finally but [g] word medially, i.e. when inflected).

Na[z]e	nose	Rie[z]e	giant (noun)
hochnä[s]i[x]	snobby (lit. high-nosed)	rie[z]i[k/x]	giant (adj)
hochnä[z]i[g]e	snobby (inflected)	rie[z]i[g]e	giant (inflected)

Earlier, I stated that the underlying representation of *ab-* was true to the orthography. In reality it is difficult to tell if it ever surfaces as [ab]. It appears to usually devoice, perhaps because voicing neutralization tends to occur in coda positions in German in general.