Chapter 2

Typology of Intervocalic Voicing and Spirantization

Since the goal of this dissertation is to arrive at a better understanding of the phonetic bases of the lenition of intervocalic stops, its starting point must naturally be a typology of such lenition. The following survey is based on the work of Gurevich (2004), who has codified previous typological databases of lenition by Lavoie (2001) and Kirchner (2001b) and expanded them by compiling the segment inventories of the relevant languages. Gurevich's database includes 153 languages, of which 136 (those for which she was able to obtain a full consonant inventory) are analyzed here. The table in appendix 7.1 summarizes her findings as they are relevant to this study.

As acknowledged by its creators, this database is not exhaustive, nor is it designed to be a typologically balanced sample. The numbers reported below therefore have dubious statistical value. The importance of this survey is that it presents a rough picture of the types of lenition processes affecting intervocalic stops that are attested in natural language, and it provides suggestive evidence as to whether some kinds of processes are more common than others. But the smaller the numbers involved (especially when very specific processes are under consideration), the more skeptical we should be of how representative they are.

Gurevich's (2004) database contains information on a broad range of lenition processes; thus, only a subset of the processes described in it affect intervocalic stops (93 of the languages have at least one such alternation). §2.1 gives an overview of the basic types of processes found in the database that affect intervocalic stops. §2.2 examines the effect of place of articulation of the targeted stops, and §2.3 examines the role of contrast maintenance.

Two kinds of counts are given in the following tables: counts of alternations and counts of languages. Here, an 'alternation' is a change affecting a single segment and may in fact represent only part of a larger phonological phenomenon. In Tiberian Hebrew, for example, voiced and voiceless stops (a total of six segments) undergo spirantization; this pattern is coded as six separate 'alternations' (one for each segment). This method of coding is intended to reflect the extent of the effect of lenition and to aid the breakdown by place of articulation detailed in §2.2; the term 'alternations' is adopted for convenience and is not intended to represent a claim about the phonological (dis)unity of the relevant phenomena.

2.1 Lenition of Intervocalic Stops: General Observations

Table 2.1 summarizes the lenition processes in the database that target voiceless stops, and table 2.2 those that target voiced stops. 61 languages in the database lenite voiceless stops, and 56 lenite voiced stops. Voicing is overwhelmingly the most common process affecting voiceless stops, followed by spirantization and simultaneous voicing and spirantization. Spirantization is most common for voiced stops. A significant number of stops of both types undergo flapping (only alveolars and retroflexes are affected), and several more undergo approximantization.

Table 2.1: Lenition of voiceless stops

Type of Lenition	**Number of Languages**	**Number of Alternations**
Voicing	26	90
Spirantization	17	29
Both	11	22
Other	14	29
Approximantization	*5*	*16*
Flapping	*5*	*5*
Debuccalization	*3*	*5*
Glottalization	*3*	*3*

2.2 Place of Articulation

It is not a given that all voiceless stops, or all voiced stops, will behave the same way with respect to lenition. One factor that might be expected to have an

Table 2.2: Lenition of voiced stops

Type of Lenition	**Number of Languages**	**Number of Alternations**
Spirantization	42	81
Other	26	35
Flapping	*18*	*18*
Degemination	*2*	*8*
Approximantization	*3*	*3*
Lateralization	*2*	*2*
'Lenition'	*2*	*2*
Debuccalization	*1*	*1*
Deaspiration	*1*	*1*

effect on a given stop's behavior is its place of articulation; indeed, to the extent that the effect of place on stops' perceptual or articulatory properties is mirrored in the typology of lenition, we have correspondingly strong (or weak) evidence that those phonetic factors are driving the attested phonological patterns. This section compares how often intervocalic stops lenite at three major places of articulation; if stops at one place are especially prone (or resistant) to a certain kind of lenition, we may expect to find some phonetic motivation for that fact.

Stops are grouped into three broad categories of place: labials, coronals (dentals, alveolars, and retroflexes), and dorsals (velars). Labialized and palatalized consonants are classified with their primary place of articulation; for example, labialized velars are classified as dorsals. Palatals and uvulars are excluded entirely.

For each place of articulation, table 2.3 gives the number of languages with a voiceless stop at that place and, of those, the number that target that stop for voicing intervocalically (possibly among other environments). The first column in table 2.4 counts languages that single out one place of articulation for voicing; the second column counts languages that voice at every place but one. (Only languages with voiceless stops at all three major places were counted for the latter table.)

Table 2.3: Number of languages with voicing of voiceless stops by place

POA	Number with Voiceless Stop	Number with Voicing	Percent with Voicing
Labial	122	21	17%
Coronal	133	24	18%
Dorsal	134	23	17%

Table 2.4: Number of languages with selective voicing of voiceless stops by place

POA	Only Target	Only Non-target
Labial	1	1
Coronal	1	0
Dorsal	1	0

The rate of voicing of voiceless stops is essentially identical at all three major places of articulation: 17% of the languages voice intervocalic labials; 18%, coronals; and 17%, dorsals. Among languages with voiceless stops at all three places of articulation, no place seems to be consistently singled out to be voiced (or not voiced); however, as there are only four languages in the database with patterns of this type, it is impossible to draw firm conclusions. Overall, place of articulation does not seem to affect the likelihood that a given voiceless stop will be targeted for intervocalic voicing.

Tables 2.5 and 2.6 are analogous to tables 2.3 and 2.4, respectively; they summarize the interaction between place of articulation and intervocalic spirantization of voiceless stops. Again, the rate of spirantization is essentially the same at each place (8% for labials, 5% for coronals, and 7% for dorsals). Similarly, no place stands out as frequently singled out for (non-)spirantization, except perhaps that coronals are less likely to be the lone spirantizers than labials or dorsals. Overall, though, spirantization, like voicing, does not seem to interact with place of articulation.

Table 2.5: Number of languages with spirantization of voiceless stops by place

POA	**Number with Voiceless Stop**	**Number with Spirantization**	**Percent with Spirantization**
Labial	122	10	8%
Coronal	133	6	5%
Dorsal	134	9	7%

Table 2.6: Number of languages with selective spirantization of voiceless stops by place

POA	**Only Target**	**Only Non-target**
Labial	5	1
Coronal	1	1
Dorsal	5	2

Tables 2.7 and 2.8 give the same information for the spirantization of voiced stops. Here, a slightly different picture emerges: coronals are less likely than either labials or dorsals to spirantize. They spirantize at a lower rate (19% versus 34% for labials and 30% for dorsals), and this difference even approaches significance ($p = .025$ for the difference between labials and coronals and .10 for the difference

between dorsals and coronals, without adjustment for multiple comparisons). In addition, of languages with voiced stops at all three major places, seven spirantize labials and dorsals to the exclusion of coronals; labials are never singled out in this way and only one language (Dahalo) singles out dorsals as non-spirantizing. However, it is possible that the apparent recalcitrance of coronals simply reflects the fact that only coronals (alveolars and retroflexes) are subject to flapping – in other words, many coronals that would otherwise be targeted for spirantization flap instead. Indeed, if we add the coronals that flap to the counts in table 2.7, the number of coronals targeted for lenition rises to 32 (34%), the same rate as labials and dorsals.

The rate of spirantization for labials is very close to that of dorsals. The counts suggest that if there is a difference at all, spirantization may preferentially target labials over dorsals. Labials spirantize at a slightly higher rate (although the difference is not significant; $p = .67$), are singled out for spirantization in nine languages versus five for dorsals, and are never the only place *not* spirantized. But since the numbers involved are extremely small and the language sample is not necessarily balanced, it is possible that this trend is an artifact of this particular dataset.

Table 2.7: Number of languages with spirantization of voiced stops by place

POA	**Number with Voiced Stop**	**Number with Spirantization**	**Percent with Spirantization**
Labial	96	33	34%
Coronal	95	18	19%
Dorsal	89	27	30%

Note that these findings do not necessarily agree with statements elsewhere in

Table 2.8: Number of languages with selective spirantization of voiced stops by place

POA	**Only Target**	**Only Non-target**
Labial	9	0
Coronal	3	7
Dorsal	5	1

the literature on the propensity of various segments to lenite. For example, Harris (1990, fn. 3) cites Foley (1977) as claiming that velars lenite more than labials, which in turn lenite more than coronals. To the extent that Gurevich's database supports any differences by place of articulation, it suggests that if anything, velars are *less* likely to spirantize than labials.

2.3 Segment Inventory and Contrast Maintenance

It is well known that phonological patterns are sensitive to the need to maintain contrasts within the segment inventory (see Flemming (2002) and Padgett (2003), among many others). Gurevich (2004) shows that lenition processes as a class seem to be particularly sensitive to (the avoidance of) neutralization: only a handful of the lenition processes in her database lead to neutralization. Since these types of systemic pressures are known to influence lenition processes such as intervocalic spirantization, it is possible that factoring out the effects of contrast maintenance would lead to a different picture of the propensity of various places of articulation to spirantize.

For example, the data in the previous section provided suggestive evidence that voiced coronals are less prone to spirantize than voiced stops at other places of articulation, and that voiced labials may be slightly more prone to spirantize than voiced dorsals. If, for independent reasons, systemic pressures have a disproportionate influence on certain places of articulation, then we could conclude that the observed asymmetries are not the result of an inherent tendency for languages to spirantize some places of articulation more than others.

There are at least two ways systemic facts might interact with spirantization. First, if a language already has a contrast between a voiced stop and a voiced spirant at some place of articulation, then spirantization at that place of articulation would lead to neutralization and is therefore likely to be avoided. Therefore, if there are more languages with [ɣ] than with [β], then there are more languages that are free to spirantize labials than dorsals without fear of neutralization.

Second, if a language has voicing of voiceless stops in at least some of the contexts where it already has voiced stops, then spirantization would be a way to maintain the contrast between the two series in the relevant environments. (In fact, Silverman (2006) argues that pressure from intervocalic voicing is the primary, or perhaps the only, motivation for intervocalic spirantization.) Therefore, if there are more languages that voice /p/ in the relevant contexts than languages that voice /k/, then there are more languages that are pressured to spirantize labials than dorsals in order to maintain the relevant contrast.

Tables 2.9 – 2.11 present counts of the languages in Gurevich's (2004) database, broken down by the systemic possibilities discussed above. Each table includes only those languages that have a voiced stop at the relevant place of articulation (thus, those languages with a possibility of spirantizing). The first two lines of each table report the number of languages with and without the relevant contrasting voiced fricative; the tables for labials and coronals also report the number of languages with [v] and [z], respectively – although spirantization yields these segments less often than [β] and [ð], it is possible that they might nevertheless be systemically relevant. The second two lines of each table report the number of languages with and without voicing of voiceless stops at the relevant place of articulation, where voicing takes place in at least some of the same environments as spirantization. Languages that were reported to lack the relevant voiceless stop altogether were included and were classified as not having voicing, since any spirantization that does occur takes place without being 'pushed' by voicing of another series.

Table 2.9: Number of languages with spirantization of /b/ by presence of /β/ and voicing of /p/

	Spirantization	No Spirantization	Percent with Spirantization
/β/ (/v/) Present	0 (9)	4 (15)	0% (38%)
/β/ Absent	24	44	35%
/p/ → [b]	2	3	40%
/p/ ↛ [b]	31	60	34%

Table 2.10: Number of languages with spirantization of /d/ by presence of /ð/ and voicing of /t/

	Spirantization	No Spirantization	Percent with Spirantization
/ð/ (/z/) Present	0 (12)	4 (36)	0% (25%)
/ð/ Absent	6	37	14%
/t/ → [d]	3	2	60%
/t/ ↛ [d]	16	75	18%

At all three places of articulation, languages are less likely to spirantize at

Table 2.11: Number of languages with spirantization of /g/ by presence of /ɣ/ and voicing of /k/

	Spirantization	No Spirantization	Percent with Spirantization
/ɣ/ Present	1	8	11%
/ɣ/ Absent	26	54	33%
/k/ → [g]	2	2	50%
/k/ ↛ [g]	25	60	29%

a given place of articulation when the spirant is already present contrastively. No languages with /β/ or /ð/ spirantize /b/ or /d/, respectively, and only one language with /ɣ/ spirantizes /g/ (Shina). By contrast, languages without contrasting spirants spirantize at a rate of 35%, 14%, and 33% for labials, coronals, and dorsals, respectively. However, since none of these differences are statistically significant, they should be interpreted with caution. In addition, the presence of /v/ or /z/ seems to have no effect on the propensity of a language to spirantize /b/ or /d/; the rates of spirantization for languages with and without these segments are very similar.

These results suggest that Gurevich's conclusion about lenition processes as a whole holds for intervocalic spirantization specifically as well: spirantization is sensitive to contrast maintenance and avoids neutralization. In addition, we see that a few more languages have /ɣ/ than /β/; it is just possible, then, that it is a higher incidence of /ɣ/ than /β/ that leads to the smaller number of languages spirantizing dorsals than labials. In order to draw firmer conclusions, though, a more rigorous typological study would be necessary. Only four languages have /ð/; thus, it is highly unlikely that the low rate of spirantization of /d/ is the result of languages avoiding neutralization with /ð/.

The numbers above also suggest a role played by voicing of voiceless stops. At each place of articulation, a greater proportion of languages with voicing also spirantize than languages without voicing. Again, though, the numbers are too small to be statistically significant. (The results for the coronals come closest; $p = .082$.) In addition, the number of languages with voicing is very similar at each place of articulation, suggesting that independent patterns of voicing of voiceless stops are not likely to account for the different rates of spirantization at various places of articulation.

Finally, these results present us with the opportunity to investigate the strong and interesting claim of Silverman (2006) referred to above. Silverman discusses the case of Corsican, which has both intervocalic voicing of voiceless stops and intervocalic spirantization of voiced stops. He argues that intervocalic spirantization is not a 'natural' sound change, but rather one that is motivated by considerations of contrast maintenance:

> The idea, then, is that intervocalic spirantization arises *in functional response* to the phonetically natural #[t]-V[d]V alternation. Just as [t] naturally moves towards [d] intervocalically largely for *phonetic* reasons, the *other* [d] here will *not* be pushed in any particular direction for phonetic reasons, but instead will gradually be pushed toward [ð] largely for *functional* reasons, since tokens with fricative variants were communicated more successfully to listeners, while variants that remain [d]-like will be more confusable with those intervocalic [d]s that alternate with word-initial [t]....
>
> To summarize, the example of Corsican reveals something very important about the inter-relatedness of contrastive sounds that each has its own [sic] set of allophonic alternants: while phonetic pressures may pull one sound towards a context-specific *more* natural state, functional pressures may, in response, push an opposing sound to a

context-specific *less* natural state.
(pp. 165-166, italics original)

Although Silverman is likely correct that intervocalic voicing encourages intervocalic spirantization – and the data above provides additional evidence for this view – his claim that neutralization avoidance is the *only* (or even the primary) motivation for intervocalic spirantization cannot be supported. Of the languages with spirantization counted in tables 2.9 – 2.11, the vast majority do *not* also have voicing of voiceless stops (94%, 84%, and 93% for labials, coronals, and dorsals, respectively);[1] thus, Silverman's claim that "[spirantization] is usually found in languages that *also* have a #[t]-V[d]V alternation as well" (p. 165) is simply false. If spirantization is unnatural but can be forced by voicing of another stop series, where do all of the languages with spirantization but no voicing come from? The results of Experiment 2 suggest that part of the answer may be voiced stops' high degree of confusability with voiced spirants, although the question of what induces voiced stops to change at all remains unanswered. Again, articulatory factors may play a role, although as Silverman (2006, 165) correctly points out, any claims about the influence of articulation must be supported with more direct evidence than is currently available. Indeed, the results of Experiment 1 support Silverman's contention that considerations of effort reduction do not directly encourage intervocalic spirantization.

Incidentally, Silverman's argument from typological evidence that intervocalic spirantization is articulatorily unnatural is not supported by Gurevich's data either. He argues that intervocalic spirantization is shown to be unnatural because

[1] Northern Corsican, which is Silverman's case study, was excluded from this analysis because its segment inventory is not given in Gurevich (2004). Even if it is included, the numbers remain high: 91%, 80%, and 89% for labials, coronals, and dorsals, respectively.

intervocalic *voiceless* stops rarely spirantize, especially not to voiced spirants. However, table 2.1 above shows that although spirantization of voiceless stops is less common than either voicing of voiceless stops or spirantization of voiced stops, the /T/ → [S] pattern is nevertheless robustly attested, and even the /T/ → [Z] pattern is far from nonexistant. Thus, intervocalic spirantization is a well-attested option across languages, places of articulation, and voicing of the affected stops.