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Consonant Strength: Results of a Data Base Development Project*

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The term *lenition* is often used to describe sound changes, both historical and synchronic, but the range and limits of lenition have not been well-defined. This report presents the results emerging from a data base of consonant strength alternations from over 165 languages. The data base represents a significant advance in the study of consonant strength by providing specific examples in sufficient quantity to compare types and frequency of alternations across languages. These generalizations demonstrate that common notions of lenition, rooted in historical change, over-regularize the phenomenon. The logically possible types of lenition and fortition are not evenly distributed; some are overwhelmingly common and others practically non-existent. The environments of alternations are often overlooked but crucial in determining if an alternation is lenition or fortition. The data base shows that consonant strength behavior exhibits asymmetries when compared to standard assumptions of sonority and consonant strength.

1 Introduction

Historical linguistics frequently refers to changes in consonant strength—*lenition* or weakening and *fortition* or strengthening—without providing an explicit definition of consonant strength. Hyman (1975:165), cited in both Escure (1977) and Bauer (1988), defines weakening as follows, noting his debt to Vennemann for the definition: "a segment X is said to be weaker than a segment Y if Y goes through an X stage on its way to zero." The sequence of historically attested changes from Latin on the way to French (Jasanoff 1993) in (1) exemplifies this definition. The segment [t] lenites to [d], and [d] lenites to [ð], which deletes altogether.

(1) t › d › ð › ø

patrem › padrem › peðre › père			'father'
Latin		French	

Besides describing historical changes, the term lenition is also applied to similar synchronic changes. Phonology textbooks usually introduce lenition with just a few examples—usually intervocalic voicing and word-final devoicing. Lenition is often written off as assimilation to the voicing of surrounding vowels or to the presumed, though seldom actual, silence at the end of a word. The notions of lenition and fortition are assumed to be intuitive and easy to grasp although they are not entirely straightforward. Besides the fact that many segment types, such as glottalized consonants, affricates, and glides, are overlooked in discussions of consonant strength, the main problem is that the two

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commonly-noted lenition environments—intervocalic and word-final—host different changes. Intervocalically we often find voicing but word-finally we find devoicing. If both voicing and devoicing are considered lenition, the term must be too broadly defined. The environment is essential in determining whether a change is lenition or fortition.

While my long term goal is a comprehensive theoretical treatment of lenition, the current work is descriptive. My data base contains examples of both lenition and fortition, but the discussion here concentrates on lenition. The data base provides a count of occurrences of certain types of lenition found in a search of over 200 languages.

Some common examples of lenition can illustrate the issues involved. In (2) the voiceless stop weakens to a flap (voiced sonorant) intervocalically. In (3) the Spanish voiced stop weakens to a voiced continuant. In (4) the German final voiced stop weakens to a voiceless stop in word-final position. These three examples represent the most common types of lenition. In (2) and (3) the lenition is an increase in sonority, but in (4) it is a decrease in both sonority and distinctiveness. Word-final devoicing as exemplified in (4) has received attention elsewhere in the literature and will not be the focus here.

(2)	American English	a	[pʰæt]	'pat'
		b	[pʰæɾ̲ɚ]	'patter'
(3)	Spanish	a	[b̲eso]	'kiss' n. (in isolation or breath group initial)
		b	[ese β̲eso]	'this kiss' (Bakovic 1995)
(4)	German	a	[bʊnd̲əs]	'federation,' gen. sg.
		b	[bʊnt̲]	'federation,' nom. sg.

Lenition has received relatively little attention from generative phonology. The work that has appeared (Bauer 1988, Escure 1977, Foley 1970, Szende 1992, Vennemann 1988) does not provide an entirely satisfactory explanation. Explanations rely variously on phonological strength (Foley 1970), strength of environments (Escure 1977), posterior cricoarytenoid (PCA) muscle tension (Bauer 1988), rapid or colloquial speech (Szende 1992), and impedance of voiced air flow (Vennemann 1988). None of these explanations applies to all cases but to find a better one we need a clearer picture of the behavior and limits of lenition.

Linguists seem to formulate statements about lenition based on their personal experience with sound change so no collections of data are readily available to validate their statements (Arlotto 1972, Hock 1991). Crowley (1987:26) states: "The concept of lenition is actually not very well defined, and linguists who use the term seem to rely more on intuition or guesswork than on detailed understanding of what lenition is."

To understand lenition thoroughly, we need to amass enough data to make generalizations, which is precisely what I have done by developing a data base that includes alternations from a wide range of languages. The rest of this report describes my working definition of consonant strength, the range of changes the data base contains, the development of the data base, and the relative frequency and environments of the alternations in the data base. I also discuss a number of issues raised by the data base. I do not yet present a theoretical analysis of these data,.

2 Consonant Strength

I follow Vennemann's (1988) general discussion of consonant strength: the strength of a consonant is in inverse relation to its place on the sonority scale, so that the consonants with highest sonority are the weakest and the consonants with lowest sonority are the strongest. (5) Consonant Strength Hierarchy (Vennemann 1988)

strongest consonant	voiceless plosives	lowest sonority
	voiced plosives	
	voiceless fricatives	
	voiced fricatives	
↓	nasals	↓
	lateral liquids	
	central liquids	
weakest consonant	[glides][1]	
	high vowels	
	mid vowels	
	low vowels	highest sonority

Even though the hierarchy in (5) is very inclusive of segment types, some segments, such as approximants, are missing. Some version of the hierarchy in (5) is widely-assumed, although a few linguists are not in complete agreement with the rankings. Crowley (1987:26) says "Linguists speak of some sounds being relatively 'stronger' or 'weaker' than others." He has a chart that, counter to most assumptions, lists [b] as stronger than [p]. He points out that the "generalizations one can make regarding these correspondences are that voiced sounds can be considered 'stronger' than voiceless sounds." The rest of his discussion of strength agrees with the common assumptions: "Similarly, stops rank higher than continuants in strength, consonants are higher than semi-vowels, oral sounds are higher in rank than glottal sounds, and front and back vowels rank higher than central

[1]Vennemann does not include glides in his chart, but I have included them here for the sake of completeness and the importance of glides to these issues.

vowels. When phonetic change takes place, it is very often in the direction of strong to weak."

Crowley's inclusion of glottal sounds in his description of lenition is noteworthy because glottals, consonants with no oral place and clearly weaker than oral sounds, are often omitted from discussions of lenition. Geminates are assumed to be stronger than singletons because of their greater duration. It is not clear if affricates are stronger than corresponding stops because affrication may be a step toward fricativization. To encompass more segment types, I maintain that anything seemingly added to a consonant, like aspiration or glottalization, makes the consonant stronger by increasing the articulatory effort and/or duration. Coda neutralization, which usually takes the form of coda devoicing, is often considered weakening but it is instead a loss of distinctive information based on prosodic position and not properly considered lenition. The next section makes clear exactly what alternations are considered in the data base.

3 The Alternations

The scope of lenition and fortition could be construed quite widely so that many and varied changes might fall under lenition and fortition. To treat consonant strength systematically, we need to establish the set of alternations that revolve around strength. Tables 1 and 2 summarize the alternations in the data base. Each row represents an alternation as a relationship between a pair of segments. The illustrations here are labials but similar pairs exist for coronals, velars, and sometimes palatals. Table 1: Lenition Pairs shows the range of weakening alternations in the data base. The segments in the left column are stronger than those in the right.

segment type	stronger	›	weaker	segment type	change in:
voiceless	p	›	b	voiced	voicing
stop	p	›	ɸ, f	fricative	continuancy
affricate/contour	pf	›	p	plain/simple	complexity
geminate	pp	›	p	singleton	complexity
aspirated	p^h	›	p	plain	vocal fold behavior
glottalized	p'	›	p	plain	vocal fold behavior
fortis, strong artic.	p	›	b	lenis[2], weak artic.	force of articulation
fricative	v	›	w, β, ʋ	approximant or glide	frication or sonorancy
stop	p, b	›	w, β	oral sonorant	sonorancy
buccalization	p, f	›	h, ʔ	debuccalization	oral contact
any segment	any	›	ø	deletion	all specifications

Table 1. Lenition Pairs

Table 2: Fortition Pairs shows the more limited range of strengthening alternations in the data base. The shaded bottom rows of the table are the non-instantiated types of fortition. There are significantly fewer pairs represented as fortition. The smaller number of strengthenings may be a result of a bias toward selecting the stronger segment as underlying form with weakening in certain positions. Note that Tables 1 and 2 present the same segment pairs, simply reversed in strength.

segment type	weaker	›	stronger	segment type	change in:
voiced	b	›	p	voiceless	voicing
fricative	ɸ, f	›	p	stop	continuancy
plain/simple	p	›	pf	affricate/contour	complexity
singleton	p	›	pp	geminate	complexity
plain	p	›	p^h	aspirated	vocal fold behavior
plain	p	›	p'	glottalized	vocal fold behavior
lenis, weak artic.	b	›	p	(fortis, strong artic.)	force of articulation
approximant or glide	w, β, ʋ	›	v	(fricative)	frication or sonorancy
oral sonorant	w, β	›	p, b	(stop)	sonorancy
debuccalization	h, ʔ	›	p, f	(buccalization)	oral contact
deletion	ø	›	any	(become segment)	all specifications

Table 2. Fortition Pairs

[2]Fortis/lenis oppositions are discussed at length elsewhere in the literature. While they seem to be based on articulatory effort, fortis/lenis is sometimes used synonymously with voiceless/voiced.

The tables illustrate that lenition and fortition are defined in relation to another segment. By linking the lenited outcome of a segment as the input to another alternation, we can form a chain of weakenings, in keeping with the intuition of a path of changes. The far right column that lists the kind of change illustrates that the changes are wide-ranging and difficult to unify under one definition or explanation.

4 Hierarchies

Bloomfield (1933) described lenition as involving successive acoustic types; this is well-illustrated with the lenition hierarchy in (6) from Jasanoff's (1993) historical linguistics course.

(6) voiceless stops → fricatives ↘
↘ ↘ glides → Ø
voiced stops → voiced fricatives ↗

This kind of hierarchy is most enlightening for those languages that have all and only the segments represented. It becomes harder to argue for successive acoustic types looking at a language that does not have all of the segments in the hierarchy, like an Australian language that lacks fricatives and phonemic voicing. If we maintain the structure preservation hypothesis, such a language cannot follow the lenition hierarchy. For these languages, the path of lenition remains an issue to explore.

Hock (1991:83) presents the more inclusive weakening hierarchy of Figure 1 which includes many segment types and possible weakening pathways.

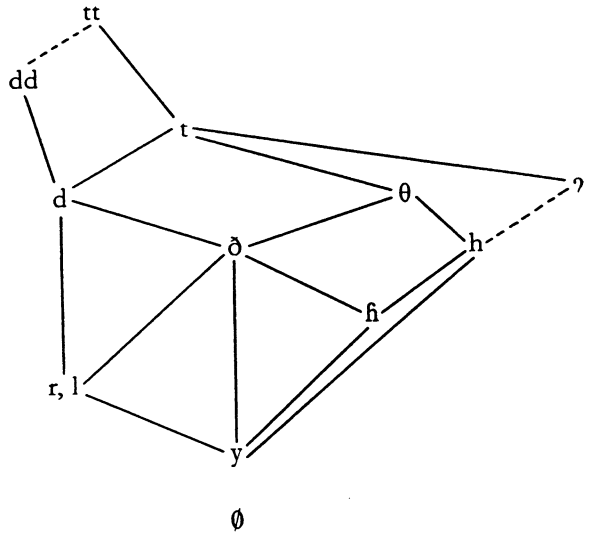

Figure 1. Hock's Weakening Hierarchy

Except for the two dotted lines indicating possible, but unattested, developments, Hock represents all of the weakenings as equally likely. The data base points out, however, that all weakenings are not equally likely. Hock provides no line between [t] and [ð], which is a common change, commoner than [t] to [θ], and he fails to include [ɾ], which is a very common lenited coronal. Hock's hierarchy has deletion as the ultimate result of lenition, but if lenition is to be understood as an increase in sonority, vocalization may well be another end result.

Although Hock scarcely mentions lenition environment, the hierarchy—to its credit—does not include cases of coda devoicing. With lenition, it is necessary to consider both the segmental and the prosodic environment. The segmental environment has received more attention, in that the most common lenition environment is said to be intervocalic. In cases where intervocalic lenition is not regular, perhaps the conditioning factor is the prosodic environment. Intervocalic environment could be translated to either stressed or unstressed position.

5 The Environments

Escure (1977) and Foley (1970) both discuss lenition environments at greater length, but neither of them discusses stress, or the lack thereof, as a possible conditioning factor. In addition to some across-the-board changes, Foley discusses intervocalic, pre-consonantal and word-final environments. Escure notes that others have stated that the strength of a consonant depends on its position in the syllable—the onset of the syllable is a strong position whereas the coda is weak. To represent this schematically and with somewhat more detail, Escure (1977) proposes a hierarchy of environments as shown below in (7) through (9), such that lenition is most likely to affect the top environment and least likely to affect the bottom environment. She also presents the scale as an implicational scale of deletability.

(7) Final
V_C(C)## or VC(C)_##
V_C#
V_#C
V_##

(8) Intervocalic
V_V
V_#V
V#_V

(9) Initial

##_V

Although Escure's hierarchy is the most inclusive I found, I do not agree with treating both final and intervocalic alternations as weakening. Escure's inclusion of morpheme and word boundaries is important in clarifying the environments. The primary sources I used in developing the data base, however, did not usually refer to boundaries so the data base has not tested these environments.

6 Data Base Development

I was spurred to develop this data base when my study of the Australian language Yindjibarndi (Lavoie 1996, Wordick 1982) revealed widespread lenition that did not follow a standard hierarchy of lenition because of its phoneme inventory. Since I found no satisfactory theoretical discussion of this situation, I began to investigate the issue and develop a data base to understand consonant strength. The first step was looking at the definitions and examples of lenition in a range of textbooks (Arlotto 1972, Bloomfield 1933, Hock 1991) where it was discussed. From that reading, I extracted a general definition of lenition and fortition to work with. Hock (1991) provided the hierarchy of many types of lenition—a set of predictions ready to be tested.

I collected a data base of changes in consonant strength to extract generalizations about the alternations. The data base was developed using primary sources in the form of grammars mostly held in the library at the University of California at Irvine. I went systematically through the grammar holdings by conducting two large-scale searches. The first search yielded a list of phonological treatments of languages which I worked through alphabetically, examining each work for alternations in consonant strength. The second search yielded a list of general grammars which I again worked through alphabetically. While my data base is not a statistically structured sample, it is large enough to address such questions as the frequency, common environments, and types of alternations.

Sixty-seven language families are represented in the data base; these include the following languages: 6 Algonquian, 2 Altaic, 1 Amazonian, 2 Arawakan, 4 Athabaskan, 5 Australian, 6 Austronesian, 3 Bantu, 2 Caddoan, 3 Carib, 1 Caucasian, 1 Celtic, 1 Chadic, 1 Sino-Tibetan, 2 Cushitic, 4 Dravidian, 1 Edo, 3 Eskimo/Inuit, 1 Ethiopian, 1 Finno-Ugric, 13 Germanic (including several dialects of English & German), 1 Gum or Abaian, 1 Gur or Voltaic, 3 Hellenic, 3 Hokan, 1 Indo-Aryan, 2 Iroquoian, 1 Italic, 1 Je, 2 Kalapuya, 1 Keres, 1 Ma'di , 1 Macro Guaicurnan, 1 Malayo-Polynesian, 1 Mandan, 1 Mandé, 2 Mayan, 1 Muskogean, 1 Nakho-Daghestanian, 8 Niger-Congo, 1 Nilo-Saharan,

1 Nilotic, 3 Numic, 1 Oto-Manguean, 2 Panoan, 1 Paezan, 3 Penutian, 3 Philippine, 1 Polynesian, 7 Romance (including creoles and dialects of Spanish), 1 Sahaptian, 1 Semitic, 2 Slavic, 1 Tai, 1 Tibeto-Burman, 1 Tsimshian, 2 Tupí-Guaraní, 3 Turkic, 1 Uralic, 5 Uto-Aztecan, 1 Volta-Comoe, 1 Yanomami, 2 Yuman, and 1 Zapotec. In addition to these languages, there were 4 isolates, 12 unclassified (or affiliation not indicated in primary source), and 3 of disputed genetic affiliation. If the primary source indicated genetic affiliation, I used that information, but if it was not included in the source, I looked it up in *Ethnologue* (Grimes 1992). If genetic information was not available in *Ethnologue*, a question mark appears in the data table.

I located alternations to include in the data base simply by scanning the grammars. Besides the phonology sections, I often looked at the morphology for alternations or at the phoneme inventory for suspicious and/or informative gaps. I did not try to examine the phonemic analyses and second-guess the underlying segments and changes. If the author had an underlying stop that fricativized in certain environments, so did I. I relied on the authors' intuitions and phonemicization of the language, always remaining faithful to the their phoneme inventories and alternations.

Information on environments of consonant strength changes was hard to find. Intervocalic alternations were indicated clearly, but few environments more complicated than that were mentioned. Sometimes a possible variation was listed, with no mention of environment and I had to search to discover it. Often just the labels of "initial position" or "final position" were used. When there were not enough examples, I examined word lists to determine if "initial" and "final" referred to words, morphemes, syllables, or some other unit. While I recorded changes that occurred in the environment of nasals (such as post-nasal occlusivization and post-nasal voicing), they are not my main focus and have received attention elsewhere in the literature. Of the types of environments currently listed in the data base, some are segmental (such as intervocalic) and others prosodic (such as post-stress). Since English flapping is best characterized by the prosodic environment of the middle of a foot, I wanted to see if the prosodic environment might be informative for other languages. Unfortunately, very few of the sources had prosodic information connected with segmental processes. Wherever possible I indicated a prosodic environment, but usually the information was not available and I could record only a segmental or syllabic context without mention of the wider prosodic structure. Consideration of prosodic environments will be valuable in the future.

The Modern Language Association (MLA) on-line bibliography yielded a handful of recent articles dealing with lenition or fortition. Most of these dealt not strictly with

lenition, but with morphological *mutation*, in particular Celtic mutations. Mutations—morphologically conditioned changes in consonant strength—are found notably in Celtic, Atlantic Niger-Congo (Fula, Mende), and Eskimo-Aleut. While mutations have received a lot of attention, they are not purely phonologically or prosodically conditioned. Since the morphology determines the segment's outcome, these examples are not the main focus of my data base. For example, a segment might weaken in the first person form, but strengthen in the same environment for the second person. Including this with the data would confound the generalizations and decrease the likelihood of determining the expected outcomes for the prosodic position. Mutations are excluded from the main portion of the data base so that they do not overly influence conceptions of consonant behavior in certain environments.

The data were all recorded in the data base in the same format. A description of the data base fields appears in Section 8.

7 Frequency of Alternations in the Data Base

The most interesting result of the data base development is the sheer asymmetry of the changes. Previous generalizations seemed to assume that the strength alternations were equally likely without mentioning the vast differences in the frequency of the changes. In the frequency tables below, the left column indicates the number of occurrences of the alternation, the next two columns indicate example segments for the alternation, and the right column describes the alternation in terms of segment types. As Table 3 illustrates, the various types of changes do not occur in equal numbers in the data base and so probably do not occur with equal frequency in natural language. Table 3 includes alternations in any environment. Due to occasional difficulty in interpreting phonetic symbols, these charts may be open to interpretation. Although the examples are labials, the numbers include alternations at any one, several, or all places of articulation. An alternation was entered in the count even if just one place in a natural class participates. More precise and helpful numbers will be found in Sections 9 and 10 with all of the individual, concrete examples.

18	p	›	b	voiceless stop › voiced
	p	›	v	voiceless stop › voiced fricative
7	f	›	v	voiceless fricative › voiced
10	p	›	ɸ, f	stop › fricative (includes vd & vl)
5	pf	›	p	affricate › simple
3	pp	›	p	geminate › singleton
1	p^h	›	p	aspirated › plain
1	p'	›	p	glottalized › plain
1	p	›	b	fortis, strong artic. › lenis, weak
	v	›	w, β, ʋ	fricative › approximant, glide
20	b	›	w, β	stop › approximant, glide
16	p, f	›	h, ʔ	oral › glottal
3	p	›	w	stop › glide
10	h	›	ø	glottal contin. › ø
1	ʔ	›	ø	glottal stop › ø
10	v, w	›	ø	oral fric/glide › ø
1	p	›	ø	oral place, manner › ø

Table 3. Total Increases in Sonority, Regardless of Environment

Of the increases in sonority, the most common were approximantizing of stops, voicing of stops and debuccalization of oral segments.

Table 4 lists the totals of alternations that resulted in decreased sonority. Rows with no number in the left column were not instantiated in the data base.

17	b	›	p	voiced stop › voiceless
	v	›	p	voiced fricative › voiceless stop
2	v	›	f	voiced fricative › voiceless
3	ɸ, f	›	p	fricative › stop
10	p	›	pf	plain/simple › affricate
2	p	›	pp	singleton › geminate
4	p	›	p^h	plain › aspirated
2	p	›	p'	plain › glottalized
	b	›	p	lenis, weak artic. › fortis, strong
	w, β, ʋ	›	v	approximant, glide › fricative
	w, β	›	b	approximant › stop
	h, ʔ	›	p, f	glottal › oral
7	w	›	p	glide › stop
	ø	›	h	deletion
	ø	›	ʔ	deletion
	ø	›	v, w	deletion
	ø	›	p	deletion

Table 4. Total Decreases in Sonority, Regardless of Environment

Just looking at the alternations by increasing or decreasing sonority is not enough; the environments of the alternations also need to be considered. Separate tables appear below for each of the following environments: initial, intervocalic, and final. Table 5 is the canonical lenition table, representing intervocalic weakenings/increases in sonority. The fact that the same types of changes occur in different environments may point out the importance of understanding the prosodic context and finding out that the environments are perhaps not that different.

12	p	›	b
3	p	›	v
4	f	›	v
4	p	›	ɸ, f
1	pf	›	p
	pp	›	p
	p^h	›	p
	p'	›	p
10	b	›	w
	v	›	w, β, ʋ
20	b	›	v, β
8	p, f	›	h, ʔ
	p	›	w
5	h	›	ø
1	ʔ	›	ø
4	v, w	›	ø
1	p	›	ø

Table 5. Number of Weakenings in Intervocalic Position

3	b	›	p
	v	›	p
	v	›	f
	ɸ, f	›	p
	p	›	pf
	p	›	pp
	p	›	p^h
1	p	›	p'
1	w, β, ʋ	›	v
	w, β	›	b
	h, ʔ	›	p, f
1	w	›	p
	ø	›	h/ʔ/w/p

Table 6. Number of Strengthenings in Intervocalic Position

Tables 7 and 8 represents the consonant strength alternations that occur in initial position. As you can see from the distribution of the numbers, the majority of the alternations in initial position are fortitions. There are only 7 lenitions in initial position. It is not certain, though, that initial position means absolute word-initial; a few word-internal, syllable-initial positions (which may be intervocalic) may be included here. Voiced segments become voiceless. Simple segments become affricates, consonants are aspirated or glottalized and glides become occlusivized.

1	p	›	b
	p	›	v
	f	›	v
2	p	›	ɸ, f
	pf	›	p
	pp	›	p
1	p^h	›	p
	p'	›	p
	v	›	w, β, ʋ
2	b	›	w, β
2	p, f	›	h, ʔ
	p	›	w
1	h	›	ø
	ʔ	›	ø
1	v, w	›	ø
	p	›	ø

Table 7. Number of Weakenings in Initial Position

4	b	›	p
	v	›	p
1	v	›	b
2	v	›	f
2	ɸ, f	›	p
6	p	›	pf
	p	›	pp
2	p	›	p^h
2	p	›	p'
2	w, β, ʋ	›	v
	w, β	›	b
	h, ʔ	›	p, f
6	w	›	p
	ø	›	h/ʔ
	ø	›	v/w/j/p

Table 8. Number of Strengthenings in Initial Position

Table 9 indicates the number of consonant strength changes in final position. Again, as with initial position, we cannot be sure that all of the environments are actually word-final; they could be word-internal, syllable final and actually be intervocalic. Final devoicing is the most common alternation in final position. Interestingly, final voicing occurs nearly half as often. Perhaps the final voicing is the true manifestation of lenition and the final devoicing is rather coda neutralization. Stops become fricatives in final position which may be the reason that all changes in final position have been considered lenition. The greatest number of deletions occur in final position.

4	p	›	b
1	p	›	v
2	f	›	v
2	p	›	ɸ, f
1	pf	›	p
3	pp	›	p
1	p^h	›	p
1	p’	›	p
	v	›	w, β, ʋ
4	b	›	w, β
2	p, f	›	h, ʔ
	p	›	w
1	h	›	ø
	ʔ	›	ø
2	v, w	›	ø
2	p	›	ø

Table 9. Number of Weakenings in Final Position

11	b	›	p
	v	›	p
2	v	›	f
	ɸ, f	›	p
1	p	›	pf
2	p	›	pp
2	p	›	p^h
	p	›	p’
	w, β, ʋ	›	v
	w, β	›	b
	h, ʔ	›	p, f
	w	›	p
	ø	›	h/ʔ/v/p

Table 10. Number of Strengthenings in Final Position

8 Data Base Fields

Table 11 lists and describes the significant fields of the data base. All of the data tables in Sections 9 and 10 appear in this format. The title appears centered at the top of eight columns of information for each alternation. **Change** provides a more specific description of the alternation, usually including the segment types involved. **Language** indicates the name of the language as it was given in the source. **Family** indicates the genetic affiliation of the language, usually as it was given in the source. If the source did not include genetic affiliation, it comes from *Ethnologue* (Grimes 1988, 1992). For a few languages, no genetic information was available and this is indicated with a question mark. **Location** lists the place where the language was or is spoken when this information was available. **Reference** includes the author and year of the source. Full citations for all references appear at the end of the paper. **S/D** indicates if the alternation is synchronic (S) or diachronic (D) whenever it could be determined. Though the synchronic/diachronic information is included in the tables, it is not currently considered in the totals. **Environ.** indicates the environment that hosts the alternation. The environments are as specific as possible based on the information available in the source. **Examples** is as exhaustive a list as possible of the segments that participate in the alternation. A hyphen separates the underlying and surface forms of each segment. The examples help to determine if all places of articulation participate in an alternation, or if some places are weaker than others.

Type of Alternation							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
A more specific statement of the alternation.	The name of the language as given in the source.	The genetic affiliation if given in the source or from *Ethnologue*	The place the language was/is spoken.	The author and date of the printed source.	Syn-chro-nic or dia-chro-nic.	The segmental or prosodic conditions for the alternation.	As exhaustive a list of changes as possible.

Table 11. Description of Data Base Fields

If an individual language has several types of weakening or strengthening, they are listed as separate entries; in this way, they are can be grouped with other similar changes to make generalizations. The order of the alternations in the tables is determined by the participating class(es) of segments in that language. The alternations appear in increasing order of sonority so that the top alternation is likely to be one whose input is a voiceless stop and the bottom alternation one whose input is a glide. Within each sonority class, the first alternations listed are those that affect only one place of articulation. These are listed

from front to back of the mouth, so that the first alternation might apply to a single labial segment. After the individual or limited segment alternations are those that affect an entire natural class. This ordering could not always be precisely followed because of alternations in which several sonority classes participated. The charts use a few abbreviations, including *vl* for voiceless, *vd* for voiced, *intervoc.* for intervocalic, *S* for synchronic, and *D* for diachronic.

9 Weakening

The kinds of weakenings found in the data base are listed below from most to least frequent with the number of occurrences. Tables listing the actual examples appear in this section, along with brief discussion of some of generalizations that they reveal.

Section	Number	Type of Weakening
9.1	29	Voicing (17 intervocalic, 12 non-intervocalic)
9.2	22	Deletion
9.3	20	Fricativization of Voiced Stops
9.4	16	Debuccalizing
9.5	15	Approximantization
9.6	10	Fricativization of Voiceless Stops
9.7	10	Sibilantization
9.8	5	Deaffrication
9.9	5	Flapping
9.10	5	Fricativization and Voicing
9.11	3	Degemination
9.12	2	Fricativization and Devoicing
9.13	1	Deaspiration
9.14	1	Deglottalization

9.1 Voicing

Intervocalic voicing is one of the most common changes regarded as lenition. Table 12 lists only examples of intervocalic voicing. Usually, all places of articulation are voiced. This contrasts with fricativization, where often just single segments alternate.

Intervocalic Voicing							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
voice stop	Périgourdin	Romance	France	Marshall (1984)	S	intervoc.	p-b
voice stops	Gooniyandi	Australian	Western Australia	McGregor (1990)	S	intervoc.	p-b; unclear on coronals
voice vl velar stop	Kannada	Dravidian	India	Chisum (1975)	S	intervoc.	k-g
voice stops & frics	German, Pennsylv.	Germanic	USA	Kelz (1971)	S	intervoc.	p-b, t-d, k-g, f-v, s-z, x-j
voice stops & affricate	Sanuma	Yanomami	Brazil and Venezuela	Borgman (1986)	S	intervoc.	p-b, t-ɾ, k-g, ts-dz
voice stops optionally	Yankuny-tjatjara	Australian	Australia	Goddard (1985)	S	intervoc.	p-b, t-d, k-g
voice stops optionally	Urubu-Kaapor	Tupí-Guaraní	Brazil	Kakamasu (1986)	S	intervoc.	p-b, t-d, k-g or ɣ
voice stops optionally	Totonac, Misantla	isolate	Mexico	MacKay (1984)	S	intervoc.	p-b, t-d, c-j, k-g
voice stops & conts.	Tahltan	Athapaskan	Canada	Nater (1989)	S	intervoc., word final	t-d, s-z ts-dz, tʃ-dʒ,ɬ-l,k-g,x-ɣ
voice lenis stops	Kuna, Paya	Zapotec?	Colombia & Panama	Pike, Forster & Forster (1986)	S	intervoc.	lenis stops - voiced fricatives
partly voice neutral stops	Yana	Hokan	USA	Sapir & Swadesh (1960)	S	before V	b-b, d-d, j-j, g-g, ʔ-
voice stops & s	Macushi	Amazonian	South America	Abbott (1991)	S	post-nas. & intervoc.	p-b, t-d, k-g, s-z
voice fricatives	Sekani	Athabaskan	Canada	Hargus (1988)	S	when prefixed, prob. intervoc.	s-z, ɬ-l, yh-y, x-gh, wh-w

Table 12. Intervocalic Voicing

Table 13 lists examples of voicing that occur other than intervocalically. Environments listed as medial appear in this table even though they may be intervocalic.

Non-Intervocalic Voicing							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
voice stop	Gitksan	Tsimshian	Canada	Hoard (1978)	Unsure	pre-vocalic (initial?)	p-b
voice stops p, k	Turkic, Old	Turkic	Turkey	Hitch (1989)	D	medial	p-b, k-g
voice *t	Oscan and Umbrian	Italic	Italy	Buck (1904)	Unsure	final	t-d(-ø)
voice k	Apalai	Carib	Brazil	Koehn & Koehn (1986)	S	word-final	k-g
voice plain vl stops	Lezgian	Nakho-Daghesta-nian	Daghestan & Azerbaijan	Haspel-math (1993)	S	word-final	pV~b#
voice stops	Senoufo	Niger-Congo	Ivory Coast, Mali	Mills (1984)	S	medial unstressed	p-b, t-d, k-g
voice stops & conts.	Tahltan	Athapaskan	Canada	Nater (1989)	S	intervoc., word final	t-d, s-z ts-dz, tʃ-dʒ,ɬ-l,k-g,x-ɣ
voice stops	Canela-kraho	Je	Brazil	Popjes & Popjes (1986)	Unsure	medial	p-b, t-d, k-g
voice stops & s	Macushi	Amazonian	South America	Abbott (1991)	S	intervoc. & post-nas.	p-b, t-d, k-g, s-z
voice interdental fric.	English, Old	Germanic	England	Kabell & Laridsen (1984)	D	after weakly-stress syll	θ-ð
voice s	Babine	Athapaskan	Canada	Story (1984)	D	stem-final	s-z

Table 13. Non-Intervocalic Voicing

9.2 Deletion

The ultimate increase in sonority may be to completely eliminate constriction, by deletion. Ten instances of [h] were deleted, as were six glides, five oral fricatives (four of them voiced velars), and one glottal stop. Voiced sounds are deleted more often than voiceless. Sounds with no oral closure were the most frequently deleted. Most of the deletions are intervocalic but some are final.

Deletion							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
delete vl t	English, Cockney	Germanic	Great Britain	Adrésen (1968)	D	intervoc. & after n,m,l	t-ø
delete vl stops	English, British	Germanic	Great Britain	Milroy, Mil.&Har. (1994)	S	final	p-ø, t-ø, k-ø
del. pal/vel frics.	Navaho	Athapaskan	USA	Kari (1976)	S	intervoc.	ɣ-ø, y-ø
delete vd vel fric.	Guerzé or Kpelle	Mandé	Togo	Casthelain (1952)	S	intervoc.	ɣ-ø
delete vd vel. fric.	Carrier	Athapaskan	Canada	Story (1984)	D	word-final	ɣ-ø
del. vd frics, esp. velars	Mongolian	Altaic	Central Asia	Poppe (1970)	D	intervoc.	ɣ-ø, g-ø
delete or glide velar fric.	Turkish	Turkic	Turkey	Underhill (76), Swift (1963)	S	intervoc.	ɣ-ø or y
delete glottal stop	Gbeya	Niger-Congo	Cen. African Repub.	Samarin (1966)	S	intervoc.	ʔ-ø
delete h, k	Finnish	Finno-Ugric	Finland	Sulkala & Karj.(1992)	S & D	word-final	k-ø, h-ø
delete h	German, Pennsylv.	Germanic	USA	Kelz (1971)	S	intervoc.	h-ø
delete h	Hawaiian	Austronesian	Hawaii	Elbert&Pukui (1979)	S	intervoc.	h-ø
delete h	Sanuma	Yanomami	Brazil and Venezuela	Borgman (1986)	S	intervoc.	h-ø
delete h	Blackfoot	Algonquian	USA, Canada	Proulx (1989)	D	intervoc., pre-C	*h-ø
delete *h	Ainu	unknown	Japan, Hokkaido	Vavin (1993)	Unsure	intervoc. probably	*h-ø
delete h	Nez Perce	Sahaptian	USA	Aoki (1970)	S	post-C	h-ø
delete h	Pawnee	Caddoan	USA	Parks (1976)	S	word-initial	h-ø
delete r	Pawnee	Caddoan	USA	Parks (1976)	S	word final	r-ø
delete glide	Kannada	Dravidian	India	Schiffman (1983)	S	intervoc.	glide-ø
delete glides	Haitian Creole	Romance	Haiti	Tinelli (1981)	S & D	final	ij-i
delete glides	Greek, Ancient	Greek	Greece	Sommerstein (1973)	Unsure	intervoc.	w-ø, y-ø, h-ø
delete glides	Blackfoot	Algonkian	USA, Canada	Frantz (1971)	S	syl-init. or after syl-init.C	w-ø, y-ø
delete glides	Tojolabal	Mayan	Mexico	Furbee-Losee (1976)	S	word-final	h-ø, w-ø, y-ø

Table 14. Deletion

9.3 Fricativization of Voiced Stops

With all types taken together, fricativization is the most common change regarded as lenition. Although fricativization of either voiced or voiceless stops would be predicted as equally common, it is not. The data base has 20 examples of fricativization of voiced stops compared to just 9 examples involving voiceless stops. For ease of comparison, separate tables throughout this section represent the various types of fricativization; the examples of fricativization of voiceless stops appear in Table 19.

Most of the languages that fricativize voiced stops do so for the entire series, but the languages that fricativize voiceless stops often do so only for one of the stops. If just one of the voiced stops fricativized, in this data it was [b]. This challenges the common assumption that velars are the weakest consonants. But perhaps the weak velars have already disappeared with [b] remaining as a fricative, as it does in Middle Korean (John Whitman, p.c.). Various lenited coronals appear in the data base. Although the flap is quite common, the interdental is far from unknown. A separate table for Flapping appears later.

Fricativization of Voiced Stops							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
fricativize vd b	Bashkir	Turkic	Bashkir Republic	Poppe (1964)	S	intervoc.	b-β
fricativize vd b	Korean, Middle	disputed	Korea	Ramsey (1991)	D	intervoc.	b-β
fricativize vd b	Périgour-din	Romance	France	Marshall (1984)	S	intervoc.	b-β
fricativize vd b	Turkic, Old	Turkic	Turkey	Hitch (1989)	D	medial	b-v
fricativize vd b, g	Kanuri	Nilo-Saharan	Nigeria	Lukas (1967)	S	intervoc., between vd sounds	b-v, g-ɣ d not involved
fricativize vd g	Koiné, Ptolemaic	Greek	Egypt	Teodorsson (1977)	D	everywhere 250 BC	g-ɣ
fricativize vd g; artic. b, d weakly	Tatar	Turkic	Tatar Rep. Western Siberia	Poppe (1963)	S	everywhere	b-β, d-ɾ, g-ɣ
fricativize vd g, r	Tojolabal	Mayan	Mexico	Furbee-Losee (1976)	S	intervoc. opt.	r-ɣ, g-ɣ
fricativize vd stops	Gothic	Germanic	Europe	Bennett (1980)	Unsure	intervoc.	b-β, d-ð, g-x or -ɣ
fricativize vd stops	Dahalo	Cushitic	Kenya	Tosco (1991)	S	intervoc.	b-β, d-ð, never g, though
fricativize vd stops	German, Pennsylv.	Germanic	USA	Kelz (1971)	S	intervoc.	b-β, d-ɾ, g-ɣ
fricativize vd stops	Mongolian	Altaic	Central Asia	Poppe (1970)	D	intervoc.	*b-v, g-ɣ, q-x
fricativize vd stops	Tzeltal	Mayan	Mexico	Kaufman (1971)	S	intervoc., word/mrph-fin, after V	b-β, d-ð, g-ɣ
fricativize vd stops	Senoufo	Niger-Congo	Ivory Coast, Mali	Mills (1984)	S	medial, weakest	b-β, d-ɾ, g-ɣ
fricativize vd stops	Efik	Niger-Congo	Nigeria	Dunstan (1969)	S	non-initial, pre-V	b-β, d-ɾ, k-ɣ
fricativize vd stops	Manobo	Philippine?	Philippines	Reid (1971)	Unsure	not sure	b-β, d-ð, g-ɣ approximants?
fricativize vd stops, maybe del.	Basque	isolate	Spain and France	Hualde (1993)	Unsure	intervoc.	b-β, d-ð/r, j-vd pal fric, g-ɣ
fric. vl asps & vd stops	Greek, Ancient	Greek	Greece	Bubeník (1983)	S & D	everywhere	ph-f, th-θ, kh-x; b-v, d-ð, g-ɣ
fricativize lenis stops	Kuna, Paya	Zapotec?	Colombia & Panama	Pike, Forster & Forster (1986)	S	word-initial	lenis stops-vd frics
fric. non-emph.stops	Hebrew, Tiberian	Semitic		Malone (1993)	Unsure	post-V or G	p-f, t-θ, k-x, b-v, d-ð, g-ɣ

Table 15. Fricativization of Voiced Stops

The tendency for fricativization to affect voiced segments is also seen in a number of examples that include both fricativization and voicing and appear in a later table. Numerous alternations in the data base are ambiguous as to whether they are a combination of fricativization and voicing or simply approximantization. The more common fricativization of voiced stops may, in fact, be a process of approximantization rather than fricativization. By this, I mean that the voiced fricatives are not very constricted, rather they are closer to glides. Phonetic symbols are not entirely clear about whether something is a voiced fricative or an approximant, for example, [β] can represent either a voiced fricative or approximant. Also supporting the idea of approximantization is that the number of voiced fricatives introduced by lenition is at odds with the highly marked nature of the voiced fricatives (Maddieson 1984). Voiced fricatives are much rarer than voiceless so it is odd that they are the more common products of lenition. This may indicate that perhaps the markedness of stable inventories is not comparable to that of possible changes. Trigo (1994) treats a similar issue—the derivation of nasalized glides. While nasalized glides are extremely rare in inventories, they do result from assimilatory changes.

9.4 Debuccalization

Debuccalization eliminates the oral constriction. Table 16 illustrates debuccalization to a glottal fricative while Table 17 illustrates debuccalization to glottal stop. Except for glides and one instance of [g], all of the debuccalized stops or fricatives were voiceless. Some glides, such as [j], may be debuccalized. Fricatives usually become [h]. The voiceless velar fricative very frequently debuccalizes. All of the segments that debuccalized to glottal stop were stops to begin with.

Debuccalization to Glottal Fricative							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
debucc. vl p to h	Kannada	Dravidian	India	Schiffman (1983)	D	word-initial	*p-h
debucc. vl k, p to h	Oscan and Umbrian	Italic	Italy	Buck (1904)	Unsure	before t	kt-ht, pt-ht
debucc. to h	Gondi	Dravidian	?	Tyler (1975)	D	intervoc.	*k-h, *r-h, *c-h
debucc. vd g to h	Ainu	unknown	Japan, Hokkaido	Vavin (1993)	Unsure	intervoc. prob. but unknown	g-h-s, not k
debucc. vl frics to h	Miami-Illinois	Algonquian, extinct	USA	Costa (1991)	D	pre-vl stops	s, x, θ, ʃ, tʃ, ç-h
debucc. vl sib. to h	Spanish, Latin American	Romance	Latin America	Lipski (1984)	S	intervoc. or wrd-fin. in poly-sylls	s-h
debucc. vl sib. to h	Greek, Ancient	Greek	Greece	Sommerstein(1973)	Unsure	pre-V	s-h
debucc. vl x to h	Chinese, Middle	Chinese	China	Pulleyblank (1984)	Unsure	?	x-h
debucc. vl x to h	Páez	Paezan	Colombia	Gerdel (1985)	S	intervoc.	x-h
debucc. vl x to h	Navaho	Athapaskan	USA	Kari (1976)	S	non-initial	x-h
debucc. vl x to h	Babine	Athapaskan	Canada	Story (1984)	D	stem-final	*x-h
debucc. j, x to h	Canela-kraho	Je	Brazil	Popjes & Popjes (1986)	Unsure	initial	j-h, x-h
debucc. w to h	Pipil or Nahuate	Uto-Aztecan	El Salvador	Campbell (1985)	S	word-final or pre-C	w-h

Table 16. Debuccalization to Glottal Fricative

Debuccalization to Glottal Stop							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
debucc. vl t to glottal stop	English, British	Germanic	Great Britain	Milroy, Milroy & Hartley (1994)	S	intervoc. and sometimes prelaterally	t-ʔ
debucc. vl k to glottal stop	Tarangan, West	Malayo-Polynesian	Maluku, Indonesia	Nivens (1992)	S	intervoc.	k-ʔ
debucc. vl stops to glottal stop	English, Cockney	Germanic	Great Britain	Adrésen (1968)	D	intervoc. and after n, m , l	t-ʔ, k-ʔ, p-ʔ

Table 17. Debuccalization to Glottal Stop

9.5 Approximantization

Only one voiceless segment, [p], approximantizes; the others are all voiced. Approximantization does not seem to affect entire place series, but rather individual segments. This table shows that many cases of lenition yield approximants rather than fricatives. Since voiced fricatives may share symbols with approximants, it is difficult to know the exact quality of the consonants and if the items in this table are truly different from those in the fricativization of voiced stops table. I have followed my primary sources in indicating if the result of voiced stop weakening is a voiced fricative or an approximant. Since the symbols are often interchangeable, this is not entirely trivial.

Approximantization							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
approx. vl p	Lama	Gur or Voltaic	Togo	Ourso & Ulrich (1990)	S	word-final	p-w
approx. alveopal	Haitian Creole	Romance	Haiti	Tinelli (1981)	S & D	final	ʒ-j
approx. vd b	Nkore-Kiga	Bantu	Uganda	Taylor (1985)	S	intervoc.	b-ʊ
approx. vd b	Yana	Hokan	USA	Sapir & Swadesh (1960)	S	intervoc.	b-w
approx. vd. d	Oscan and Umbrian	Italic	Italy	Buck (1904)	Unsure	intervoc.	d-rs
approx. vd d	Turkic, Old	Turkic	Turkey	Hitch (1989)	D	medial	d-ð-y
approx. vd d	Spanish, Latin American	Romance	Latin America	Resnick (1975)	S	past participle	ado/aðo-aw
approx. vd g & dʒ	Tarangan, West	Malayo-Polynesian	Indonesia	Nivens (1992)	S	medial, not stressed	g-w, dʒ-y
approx. vd stops	Somali	Cushitic	Somalia	Armstrong (1964)	S	intervoc., esp. after stress	b-β, d-ð, ɖ-ɾ, g-ɣ
approx. vd stops	Catalan	Romance	Spain	Hualde (1992)	S	Spanish lenition environs.	b-β, d-ð, g-ɣ
approx. vd v	Turkish	Turkic	Turkey	Underhill (1976), Swift (1963)	S	intervoc.	v-β
approx. vd v*	Yuman	Yuman	Mexico	Wares (1968)	D	pre-stress	*v-w, *v-v
approx. vd velars +	Carrier	Athapaskan	Canada	Story (1984)	D	word-final	*ɣ-y, g-y, ɢ-ɣ, gw-w

Table 18. Approximantization

9.6 Fricativization of Voiceless Stops

Voiceless stops are not usually fricativized as a whole class, but rather more individual stops fricativize than the whole class. In the two cases where the whole series of voiceless stops fricativizes, the whole series of voiced stops fricativizes as well. Velars and post-velars are the most commonly fricativized voiceless stops.

Fricativization of Voiceless Stops

Change	Language	Family	Location	Reference	S/D	Environ.	Examples
fricativize vl p	Amele	Gum or Abaian	Papua New Guinea	Roberts (1987)	S	intervoc.	p-f
fricativize vl. k	Maori	Polynesian	New Zealand	Bauer (1993)	S	everywhere	k-x
fricativize vl *k	Numic lgs.	Uto-Aztecan	Mexico	Ramer (1993)	D	intervoc.	k-x, k-h or k-ɣ
fricativize vl k, q	Nez Perce	Sahaptian	USA	Aoki (1970)	S	before k, q, n, l, final	k-x, q-post-velar fortis trill
fricativize vl q	W. Green-landic	Inuit?	Greenland	Fortescue (1984)	S	intervoc.	q-χ or ʁ
fricativize vl q	Totonac, Misantla	isolate	Mexico	MacKay (1984)	S	word-final	q-χ
fricativize glottal stop	Mataco-Noctenes	Macro Guaicurnan	Bolivia	Claesson (1994)	S	word-final	ʔ-h
fricativize vl asps and vd stops	Greek, Ancient	Greek	Greece	Bubeník (1983)	S & D	everywhere	ph-f, th-θ, kh-x; b-v, d-ð, g-ɣ
fric. non-emph.stops	Hebrew, Tiberian	Semitic		Malone (1993)	Unsure	post-V or G	p-f, t-θ, k-x, b-v, d-ð, g-ɣ

Table 19. Fricativization of Voiceless Stops

9.7 Sibilantization

Coronal and palatal stops, usually voiceless, may become sibilant fricatives. Though sibilantizing is not commonly covered in treatments of lenition, sibilant fricatives are often the outcome of a weakening process which can be identified as such on the basis of parallel changes in [p] and [k] in the same environment. It is remarkable that stops would weaken to sibilants because sibilants are not particularly lazy or reduced articulations, rather they require precise tongue placement. The palatal stops may be given to sibilantizing because they already possess something of a natural affrication. And perhaps weakening to sibilants is not really a form of lenition.

Sibilantization							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
sibilantize interdentals	Tahltan	Athapaskan	Canada	Nater (1989)	S	intervoc., word-final	tθ-ts
sibilantize t	Turkana	Nilotic	Kenya	Dimmenda-al (1983)	S	before non-back vowel	t-s
sibilantize t	Greek, Ancient	Greek	Greece	Sommerst-ein (1973)	Unsure	intervoc. pre-i	t-s
sibilantize pal stop	Nez Perce	Sahaptian	USA	Aoki (1970)	S	before n or w	c-s
sibilantize pal stop	Yonkalla	Kalapuya	USA	Berman (1990)	D	not sure	*c-s
sibilantize *c	Yuman	Yuman	Mexico	Wares (1968)	D	?	*c-s
sibilantize glot. + dent cluster	Miami-Illinois	Algon-quian, extinct	USA	Costa (1991)	D	everywhere	*hθ-hs, *ʔθ-ʔs, *ʔl-ʔs, *hl-hs
sibilantize r	Tarasco	possibly isolate	Mexico	Swadesh (1969)	S	pre-C	r-z, rh-z
sibilantize retro r and t.	Pengo	Dravidian	India	Burrow & Bhattacha-rya (1970)	D	intervoc.	ʈ-z, ɽ-z
sibilantize x, t...	Blackfoot	Algon-quian	USA, Canada	Proulx (1989)	D	not sure	*x-ss, tk-ssk, ʃk-ssk

Table 20. Sibilantization

9.8 Deaffrication

Deaffrication is a weakening—a simplification of a segment. The data are not clear on the environments. Sometimes the result is a plain stop and other times the result is a plain spirant.

Deaffrication							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
deaffricate ejectives	Kabardian	Caucasian	NW Cauca-sus	Colarusso (1988)	?	?	ej. aff - ej. spir.
deaffricate alv. aff. to strid, cont.	Shoshoni, Gosiute	Numic	USA	McLaugh-lin (1989)	S	after front V	c-z or ʒ
deaffricate, spirantize stops	Blackfoot	Algon-quian	USA, Canada	Proulx (1989)	D	before obstruents	tʃ-s
deaffricate vl	German, Pennsylv.	Germanic	USA	Kelz (1971)	D	before V	pf-p'
deaffricate & voice	German, Pennsylv.	Germanic	USA	Kelz (1971)	D	intervoc. & final	pf-b

Table 21. Deaffrication

9.9 Flapping

Flapping is quite common. Often it is simply a coronal segment that weakens, but flapping may also be part of a lenition series affecting all stops in the language. Trill [r] may also undergo flapping in a weak position. The flapping examples in Table 22 are from languages that weaken only segment. More examples of flapping as just one part of a full series of weakening appear in the fricativization tables.

Flapping							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
flap vl t	English, N. Zealand	Germanic	New Zealand	Holmes (1994)	S	intervoc.	t-ɾ
flap vl t (optional)	English, Canadian	Germanic	Canada	de Wolf & Hasebe Ludt (1987)	S	intervoc., post stress	t-ɾ
flap vd d	Sawai	Austro-nesian	Maluku, Indonesia	Whistler (1992)	S	intervoc, syll-final?, first of 2C	d-ɾ
flap/reduce trill r	Finnish	Finno-Ugric	Finland	Sulkala & Karjalainen (1992)	S & D	intervoc.	trill r-ɾ
flap l	Canela-kraho	Je	Brazil	Popjes & Popjes (1986)	Unsure	medial	l-ɾ

Table 22. Flapping

9.10 Fricativization and Voicing

When voiceless stops weaken, a number of them are both voiced and fricativized, giving support to the notion that voiceless stops do not often simply become fricatives, but that lenition is really reaching for an approximant. For Table 23, we see that the only single segment alternation is for [k]; the other alternations all affect the entire series which is more like the behavior of voiced than voiceless stops.

Fricativization and Voicing							
Change	Language	Family	Location	Reference	S/D	Enivron.	Examples
fric. vl k & voice	Basque	isolate	Spain and France	Hualde (1993)	Unsure	word-final	k-ɣ
fric. vl stops & voice	Tamil	Dravidian	India	Annamalai (1975)	S	betw. sono-rant & V-init. word	p-β, c-z, ʈ or ɾ - ɖ, k-ɣ
fric. vl stops & voice	Shoshoni, Gosiute	Numic	USA	McLaughlin (1989)	S	intervoc.	
fric. vl stops & voice	Panamint	Numic	USA	McLaughlin (1989)	S	intervoc.	p-β, t-ð, c- , k-ɣ, kw-ɣw
fric. vl stops & voice	Lumasaaba or Lugisu, south dial.	Bantu	Uganda	Brown (1972)	S	unclear	p-β, t-ɾ, k-ɣ

Table 23. Fricativization and Voicing

9.11 Degemination

Degeminate results in a shorter, weaker consonant segment. This frequently occurs word-finally. This could be interpreted either as final lenition or as a loss of contrast in coda position.

Degemination							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
degeminate	Afar	Ethiopian ?	Ethiopia	Bliese (1981)	S	word-final	geminate-singleton
degeminate	Hebrew, Tiberian	Semitic	?	Malone (1993)	Unsure	word-final	pp-p, tt-t, etc.
degeminate lenis - to fortis	Kuna, Paya	Zapotec?	Colombia & Panama	Pike, Forster & Forster (1986)	S	anywhere	fortis stops are vig. artic. and voiceless

Table 24. Degemination

9.12 Fricativization and Devoicing

Several examples in which voiced stops both fricativize and devoice appear in the data base. Since the two changes are opposite in terms of strength, the strength seems to stay the same.

Fricativization and Devoicing							
Change	Language	Family	Location	Reference	S/D	Enivron.	Examples
fricativize & devoice vd d	Guayabero	?	?	Keels (1985)	S	word-final	d-θ
fricativize & devoice voiced stops	Bontoc	Philippine?	Philippines	Reid (1971)	Unsure	syll-initial	b-f, d-ts, g-kh, l-r

Table 25. Fricativization and Devoicing

9.13 Deaspiration

Eliminating aspiration word-finally may be weakening or it may be an instance of word-final neutralization.

Deaspiration							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
deaspirate stops	Wiyot	Algon-quian	USA	Teeter (1964)	S	word-final	t^h-t

Table 26. Deaspiration

9.14 Deglottalization

Deglottalization, a type of neutralization, occurs in final position, reducing the set of contrasting segments in coda position. In other positions, deglottalization might be weakening.

Deglottalization							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
deglottalize vl stops	Maidu	Penutian	USA	Shipley (1963)	S	final	p'-p, t'-t, c'-c, k'-k

Table 27. Deglottalization

10 Strengthening

Strengthening refers to making a segment less sonorous and more consonantal. The most common environments for strengthening are word-initial and pre-stress. The kinds of strengthenings found in the data base are listed below from most to least frequent with

number of occurrences. Tables listing the actual examples appear in this section, along with a brief description of the generalizations they reveal.

Section	Number	Type of Strengthening
10.1	14	Occlusivization
10.2	11	Devoicing
10.3	10	Affrication
10.4	4	Aspiration
10.5	3	Fricativization/Approximantization
10.6	2	Gemination
10.7	2	Glottalization

10.1 Occlusivization

Occlusivization means that a segment becomes a stop. Occlusivizing often occurs initially. Some varieties of Spanish have occlusivized and affricated the palatal glide.

Occlusivization							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
occl.	Creole French	Romance	New World	Goodman (1964)	S & D	initial	v-b
occl. & devoice *v	Yuman	Yuman	Mexico	Wares (1968)	D	post-stress	*v-p
occl. frics	Burushaski	isolate/ unknown	?	Lorimer (1935)	Unsure	initial ?	x-q, ɣ-g, h-k
occl. glides	Yonkalla	Kalapuya	USA	Berman (1990)	D	initial in nouns	*y-n
occl. & nasalize r	Wichita	Caddoan	USA	Rood (1976)	S	before vowel	r-n
occl. semi-Vs to C	Apalai	Carib	Brazil	Koehn & Koehn (1986)	S	intervoc.	semivowel-cons.
occl. sonorant	Lama	Gur or Voltaic	Togo	Ourso & Ulrich (1990)	S	post-sonorant	w-p/after m, r-t
occl. vl fric.	Hausa	Chadic	Nigeria	Kraft &Kr. (1973), Dunstan (1969)	S	word-initial, esp.	ɸ-p
occl. w	Carrier	Athapaskan	Canada	Story (1984)	D	initial	*w-b
occl. w	Pawnee	Caddoan	USA	Parks (1976)	S	word-initial	w-p

Table 28. Occlusivization

Continuants often become stops when they follow a nasal so they are probably in an onset. I am not certain if th is should be considered strengthening so I have listed the examples from the data base separately in Table 29.

Post-Nasal Occlusivization							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
occl. vd frics.	Eastern Cheremis	Uralic	E. Central Russia	Ristinen (1960)	S	after nasals	β-b, ð-d, ɣ-g
occl. vd frics	Lumasaaba or Lugisu	Bantu	Uganda	Brown (1972)	S	after nasal stop	β-b, l-d, j-vd pal. stop
occl. r	Diola-Fogny	Niger-Congo	Senegal	Sapir (1965)	S	after nasal	r-d
occl. r	Tarasco	possibly an isolate	Mexico	Swadesh (1969)	S	after nasal	r-d, rh-d

Table 29. Post-Nasal Occlusivization

10.2 Devoicing

Following the sonority scale, devoicing strengthens a consonant by making it less sonorous. Since coda devoicing is really a loss of contrast, devoicing is only strengthening when it occurs in initial and medial positions. Table 30 includes devoicing in these non-final environments.

Devoicing in Non-Final Position							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
devoice geminates	Somali	Cushitic	Somalia	Armstrong (1964)	S	intervoc.	gg-kk, etc.
devoice b	German, Pennsylv.	Germanic	USA	Kelz (1971)	S	word initial	b-p
devoice implosive b	Tojolabal	Mayan	Mexico	Furbee-Losee (1976)	S	unclear	ɓ-b
devoice consonants except ð	Bashkir	Turkic	Bashkir Republic	Poppe (1964)	S	intervoc.	
devoice & fric. vd stops	Balangaw	Austro-nesian	Phillipines	Reid (1971)	S	syll-initial	b-f, d-tsh, g-kh, l-r
devoice stops	Somali	Cushitic	Somalia	Armstrong (1964)	S	initial	
devoice vd stops +	Burushaski	isolate/unknown	?	Lorimer (1935)	Unsure	intervoc, medial	b-p, d-t, g-k, ɣ-x
devoice neutral stops	Yana	Hokan	USA	Sapir & Swadesh (1960)	S	before C	b-p, d-t, j-c, g-k
devoice &/or affr.	Kalinga	Philippine	Philippines	Reid (1971)	Unsure	syll-initial	b-pi/pp, d-tʃ/dʒ, l-ɬ
devoice r	Wichita	Caddoan	USA	Rood (1976)	S	before h	r - voiceless r
devoice resonants	Tuscarora	Iroquoian	USA	Mithun Williams (1976)	S	before h, glottal stop, # or s	n-hn, r-hr, w-ɸ, y-hy

Table 30. Devoicing in Non-Final Position

Table 31 lists devoicing in final position although I do not consider these alternations to be either weakening or strengthening. These examples are included here for the sake of completeness.

Devoicing in Final Position (Neutralization)							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
devoice d	Wolof	Niger-Congo	Senegal	Diagne (1971)	S	word-final	d-t, etc.
devoice fortis & lenis	Kuna, Paya	Zapotec?	Colombia & Panama	Pike, Forster & Forster (1986)	S	word-final	fortis stops are vigorously articulated and voiceless
devoice obstruent clusters	Russian	Slavic	Russia	Halle (1971)	S	word-final	
devoice stops	Efik	Niger-Congo	Nigeria	Dunstan (1969)	S	final	b-p, d-t, not g
devoice stops	Turkish	Turkic	Turkey	Underhill (1976)	S	final	p-b, etc.
devoice stops	Czech	Slavic	Czech Republic, Slovakia	Kucera (1961)	S	final	all places
devoice stops	Sawai	Austro-nesian	Maluku, Indonesia	Whistler (1992)	S	syll-final	b-p, d-t, g-k
devoice stops	Afar	?	Ethiopia	Bliese (1981)	S	word-final	b-p, d-t, ɖ-ʈ j-c, g-k
devoice stops	Amele	Gum or Abaian	Papua New Guinea	Roberts (1987)	S	word-final	b-p, gb-p, g-k
devoice interdental fric.	English, Old	Germanic	Europe	Kabell & Laridsen (1984)	D	word-final;	ð-θ
devoice sib.	Pengo	Dravidian	India	Burrow & Bhattacha-rya (1970)	D	word-final	z-s
devoice sonorants	Nez Perce	Sahaptian	USA	Aoki (1970)	S	final	m, w, n, y, l -voiceless
devoice sonorants	Acoma	Keres	USA	Miller (1965)	S	final unacc.syll.	w, r, y - voiceless

Table 31. Devoicing in Final Position

10.3 Affrication

Affrication renders a simple segment more complex. If we take more structure to indicate greater strength, then affrication is surely fortition. Affrication, however, is often a step toward fricativization so it may actually represent weakening. The segments that affricate are overwhelmingly voiceless. Perhaps when a stop affricates, it is weakening but when a fricative affricates, it is strengthening. Only one example, Maori, seems to have a whole series affricating. In the other examples, only single non-velars are affricating.

Affrication							
Change	Language	Family	Location	Reference	S/D	Environ.	Change
affricate vl p	Burushaski	isolate/ unknown	?	Lorimer (1935)	Unsure	initial	p-pf
affricate vl p	Island Carib	Arawakan	South America	Taylor (1977)	S	initial	p-pf
affricate vl p	Turkana	Nilotic	Kenya	Dimmenda-al (1983)	S	syll-initial	p-pɸ
affricate vl p, t, ?	Maori	Polynesian	New Zealand	Bauer (1993)	S	stressed syll. initial	p-pf, t-tʃ or ts, (k-kx?)
affricate vl t	Sawai	Austro-nesian	Indonesia	Whistler (1992)	S	inter-mrph preced. by non-liq alv.	t-tʃ after n or r
affricate vl t	Tarasco	possibly an isolate	Mexico	Swadesh (1969)	S	before p or k	t-ts or t-s
affricate vl pal stop	Miwok, Plains	Penutian	California USA	Callaghan (1984)	S	final position	c-ts
affricate vl t, d	Creole, Haitian	Romance?	Haiti	Valdman (1970)	S	before i, u	t-tʃ, d-dʒ
affricate vl s opt.	Samoan	Austro-nesian	Samoa	Mosel & Hovdhau-gen (1992)	S	utterance-initial	s-ts
affricate sibilants	Catalan	Romance	Spain	Hualde (1992)	S	initial and post C	ʃ-tʃ, ʒ-dʒ

Table 32. Affrication

10.4 Aspiration

Aspirating a sound makes it stronger, by increasing its duration. The segments that are aspirated are overwhelmingly voiceless stops. This usually occurs initially.

Aspiration							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
aspirate vl p	Sanuma	Yanomami	Brazil and Venezuela	Borgman (1986)	S	word-initial	p-ph
aspirate vl stops	Gitksan	Tsimshian	Canada	Hoard (1978)	Unsure	final	p-ph, others?
aspirate vl stops	Guayabero			Keels (1985)	S	syll.-initial	p-ph, t-th, k-kh
aspirate or voice ejectives	Lezgian	Nakho-Daghes-tanian	Daghes-tan & Azerbaijan	Haspelmat h (1993)	S	word-final	net'er-neth

Table 33. Aspiration

10.5 Fricativization or Approximantization

Glides sometimes strengthen to fricatives or approximants.

Fricativization							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
fricativize palatal glide	Macushi	Amazonian	South America	Abbott (1991)		intervoc.	y-ð
approx. w	Guayabero	?	?	Keels (1985)	S	pre stressed V	w-β
approx. w	Sawai	Austro-nesian	Maluku, Indonesia	Whistler (1992)	S	word-initial before C	w-β

Table 34. Fricativization

10.6 Gemination

Geminating strengthens a segment, usually a voiceless stop. The data base contains no examples of gemination of a voiced segment; both examples involve the entire series of voiceless stops.

Gemination							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
geminate vl stops	Urubu-Kaapor	Tupí-Guaraní	Brazil	Kakamasu (1986)	S	stressed sylls. and utterance finally ?	p-pp, t-tt, k-kk, kw-kwkw
geminate vl stops +	Hixkaryana	Carib	Brazil	Derbyshire (1985)	S	syll. final before syll. init. h	p-pp, t-tt, tʃ-ttʃ, k-kk

Table 35. Gemination

10.7 Glottalization

Glottalization usually occurs word- or syllable-initially. It is difficult to know if glottalization is weakening or strengthening. It may be a prelude to debuccalizing the stop and thus weakening, but glottalization could also be interpreted as additional articulatory effort and thus strengthening.

Glottalization							
Change	Language	Family	Location	Reference	S/D	Environ.	Examples
glottalize t	English, Tyneside	Germanic	Great Britain	Carr (1991)	S	word-int and after sonorants	t-tˀ
glottalize	Capanahua	Panoan	Peru	Loos (1969)	S	initial	β-βˀ, ɾ-ɾˀ
glottalize	Turkana	Nilotic	Kenya	Dimmen-daal (1983)	S	syll-initial	b-bˀ/ɓ, d-dˀ, j-jˀ, g-gˀ

Table 36. Glottalization

10.8 Buccalization

This would be predicted as the opposite of debuccalization if there were symmetry of all strength alternations. There are, however, no examples of a glottal gaining an oral place in the data base.

11 Co-Occurrence of Alternations

Sometimes a segment is realized several strength steps away from its input form. This happens when alternations of two features occur on the same segment, either reinforcing or contradicting the general strength tendencies. The alternations may both change the strength of the input segment in the same direction or they may work in opposite directions. The antagonistic combinations of alternations make it difficult to determine what is happening to the segment. In combination with the environment in which the changes occur, it is often difficult to figure out fundamentally what kind of change it is, illustrating the fundamental inadequacies of the definition.

11.1 Cooperative Weakenings

These cooperative weakenings give the segment a significantly weaker realization. Voiceless stops do not usually just fricativize between vowels, they also tend to voice which makes them either voiced fricatives or perhaps approximants. Table 23: Fricativization and Voicing summarizes the cooperative weakenings represented in the data base. In Pennsylvania German (Kelz 1971), [pf] is deaffricated (weakened) and voiced (weakened) to [b]. In Pengo (Burrow and Bhattacharya 1970), intervocalic [t] is voiced (weakened) and sibilantized (weakened?) to [z].

11.2 Cooperative Strengthenings

Cooperative strengthenings give the segment a significantly stronger realization. In Pawnee (Parks 1976), the word initial glide [w] is occlusivized and devoiced to [p]. In Yuman (Wares 1968), post-stress [*v] was occlusivized and devoiced to [p]. In both cases, occlusivizing is a type of strengthening and so is devoicing.

11.3 Antagonistic Alternations

In antagonistic alternations, one feature changes toward greater strength and another features towards less strength. In Balangaw and Bontoc (Reid 1971), initial voiced stops are devoiced (strengthened) and fricativized (weakened). In Guayabero (Keels 1985), [d] in final position is devoiced (possibly strengthened or reduced in contrast) and fricativized (weakened).

12 Additional Issues

Many subsidiary issues have presented themselves throughout this research. I mention some of them briefly below.

12.1 Strategic Use of Phoneme Inventories

At this point, the suspicious gaps in phoneme inventories have not been fully considered when determining how lenition is working. Inventories have been used in the past to argue for the loss of segments when other members of the series remain, as in an inventory that has [β] and [ð], but not [ɣ]. The information that can be gleaned from phoneme inventories awaits further investigation.

12.2 Coronals

The coronal stops show the most variety in the type of segment that they lenite to. A coronal stop may weaken to any of these: [ɾ, d, ð, θ, s, l]. What motivates the different possible lenited segments and how can we predict the outcome of a coronal lenition? Perhaps the exact type of coronal articulation determines the lenited version. For example a retroflex [t] might well become a flap and a dental [t] might become an interdental (Bruce Hayes, p.c.) The behavior of coronals in Australian languages with lenition may be informative. In Yindjibarndi, apical coronals are not lenited while laminal coronals frequently are.

12.3 Convergence on the Flap

Many segments weaken to [ɾ], not just [t] and [d]. [l] and trilled [r] also become [ɾ] in Canela-kraho (Popjes and Popjes 1986) and Finnish (Sulkala and Karjalainen 1992), respectively.

12.4 Glottalization or Glottaling

In some varieties of English, there is an interesting and confusing situation. Some [t]s are glottalized, that is, given a glottal accompaniment, while other [t]s become glottal stops, losing their oral contact (Milroy, Milroy & Hartley 1994). In my current schema, the glottalization would be fortition but the change of [t] to a glottal stop would be lenition via debuccalization. The glottalization should not be strengthening because it is not in a strong position, but rather a weak one.

12.5 Symbols for Voiced Fricatives/Approximants

Because [β] and [ɣ] are used for both voiced fricatives and for approximants, it has been difficult to know the exact quality of the segments represented by these symbols. More investigation into the differences between voiced fricatives and approximants is warranted.

12.6 Final Position

Although I am not considering final devoicing to be lenition, I do consider final fricativization to be lenition because it does not seem to be neutralization.

13 Conclusions

This work has characterized consonant strength behavior and attempted to show which alternations may be properly considered lenition. The data base allows me to state some generalizations that had thus far gone unstated. Occlusivization, devoicing (non-final position), and affrication are the most common types of strengthening and they occur primarily in initial position. Fricativization of voiced stops, deletion of segments, and voicing are the most common types of weakening. Debuccalization, approximantization and sibilantization are also common types of weakening. The combined occurrences of voiced segment fricativization and of approximantization point to a strong tendency for segments to reduce their oral obstruction. These generalizations single out the remarkable cases and point out the types of common alternations that may be studied in more detail. The data base described in this paper provides solid information about the distribution of

consonant strength alternations and can serve as a point of departure for more detailed studies.

14 References

If the titles do not indicate what language(s) they treat, the language appears at the end of the citation in square brackets.

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