Epenthesis and Fricatives in Final Consonant Clusters

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1 Introduction

The aim of this paper is to draw a parallel between the production of word-final fricatives in consonant clusters and the occurrence of epenthesis after clusters ending in stops. Evidence is presented that speakers whose native languages disallow CC syllable codas show a preference for phonetic "release" when producing these clusters. This release is considered here as being the equivalent of a phonological continuant. It is important to note at the outset that in this study, the breadth of the category for the distinctive feature "continuant" is expanded beyond its typical scope to include the processes of aspiration and vowel epenthesis. The justification for this is that these two processes are similar to the productions of fricatives, vowels, glides, and liquids in that all are characterized by continuous airflow through the mouth.

Briefly, the data from this study show that when subjects are asked to pronounce final clusters of the type C + stop, they frequently resort to the syllable simplification processes of epenthesis, deletion, and substitution. Most often, when they are able to produce the cluster successfully, some type of the aforementioned release occurs word-finally. However, when a release is already provided in the cluster by the presence of a final fricative, the subjects are less likely to go through syllable simplification processes.

This last point could be considered quite controversial, mainly because it challenges the widely accepted Sonority Sequencing Constraint (SSC). The SSC states that the segments in a syllable become progressively less sonorous as they move away from the syllable's nucleus. On Broselow and Finer's (1991) Sonority Index, fricatives are ranked as more sonorous than stops.

(1) Sonority Index

1 – Stops	(least sonorous)
2 – Fricatives	
3 – Nasals	
4 – Liquids	
5 – Glides	(most sonorous)

Thus, stop + fricative clusters in coda position represent a violation of the SSC. Since clusters which violate the SSC are more marked than clusters which abide by it, the claim that these L2 learners will experience relatively little difficulty in producing C + fricative clusters is at odds with the SSC.

2 Epenthesis

Speakers whose native languages disallow consonant clusters in syllable codas clearly have no knowledge from their L1 of how to produce these complex codas. Therefore, when they attempt to pronounce monosyllabic words ending in CC, such as those used in this study, it is to be expected that they will often commit errors. As mentioned above, these errors – epenthesis, deletion, and substitution – demonstrate a common trend of simplifying syllable structure for the speaker. Of these three processes, only epenthesis (the insertion of a segment) plays a central part in this study. As with the term "continuant," in this paper the scope of the epenthesis category is expanded beyond the norm. As can be seen in the data presented below, subjects produced numerous examples of vowel epenthesis and aspiration. In this study, though they are represented differently in transcription, both of these processes have been combined in analysis and are referred to simply as epenthesis. This view is consistent with Weinberger (2000), who concluded:

(2) a. aspiration = [h]
    b. [h] = vowel
    c. ∴ aspiration = vowel.

Thus, aspiration is treated here as a type of voiceless vowel epenthesis.

To summarize this section, then, vowel epenthesis, voiceless vowel epenthesis and aspiration are considered to be essentially the same process for the purposes of this paper. They will be referred to here simply as epenthesis.

3 Fricatives

Roca and Johnson (1999) define a fricative as "a consonant sound that involves friction noise made by the air escaping through a narrow obstacle." As with epenthesis, the continuant property of fricatives means that there is a desirable phonetic release (airflow) in production. It is argued, then, in contrast with the SSC, that final clusters that end in fricatives should generally be easier for subjects to produce correctly than final clusters that end in stops.

4 Subjects

Three Japanese speakers, three Spanish speakers, two Mandarin speakers, and two Indonesian speakers (Subjects 1 – 10) were used for this study. All are adult students of English as a Second Language (ESL) at an Intensive English Program located in Arlington, Virginia. They were chosen specifically because consonant clusters do not appear in coda position in their languages. English is the only language they speak which allows final consonant clusters. In addition to Subjects 1 – 10, one native speaker of American English was tested to act as a control. Below are the profiles for each subject and the control.

Table 1
Subject profiles

Subject	Birthplace	L1	Age	Onset age	Sex	Residence
S1	Santiago, Chile	Spanish	29	12	Female	1.5 years
S2	S. Cristobal, Venezuela	Spanish	23	11	Female	7 months
S3	Lima, Peru	Spanish	29	12	Male	3.25 years
S4	Iwata, Japan	Japanese	36	14	Male	2.75 years
S5	Tokyo, Japan	Japanese	20	13	Female	6 months
S6	Fukuoka, Japan	Japanese	22	13	Female	1.5 years
S7	Beijing, China	Mandarin	28	16	Male	1.75 years
S8	Shanghai, China	Mandarin	41	30	Male	1 year
S 9	Sumatra, Indonesia	Indonesian	29	27	Male	6 months
S10	Jakarta, Indonesia	Indonesian	25	14	Female	5 months
Control	Philadelphia, USA	American English	47	0	Male	47 years

5 Methodology

The subjects in this study were informed that they would be providing data for a phonological study by reading a list of nonsense words. They were told that they would be recorded on audiotape but were not made aware of the specific focus of the study.

Each subject was asked to pronounce 35 nonsense words, all of which ended in consonant clusters. Nonsense words were used instead of English words to ensure that errors based in morphology would be avoided. The structure of each word was CVCC, with all segments allowable in English. As indicated above, for the purposes of this study, the final consonant of each cluster could only be a fricative or a stop. English "silent *e*," affricates, θ, etc. were not used so that all words would be structurally uniform, all orthographically ending in two independently pronounceable consonants.

Each word was presented to the subjects on index cards one at a time. The subjects first stated the carrier phrase "Now I say…" and then read each word aloud for the recording. The carrier phrase was used to provide a consistent phonological environment before each target word, making it less likely that subjects would link words and thus form larger clusters.

6 Predictions

In accordance with the observations already made in this paper, the following results were predicted for the final clusters in the data:

6.1 C + fricative clusters:

a. high rate of faithfulness to cluster; i.e., no syllable simplification errors in cluster (fricative = word-final release)
b. low rate of epenthesis because fricative provides final release

6.2 C + stop clusters:

a. low rate of faithfulness to cluster due to absence of final release
b. high rate of epenthesis following intact clusters (epenthesis = release)

7 Results

The transcriptions for the ten subjects and one control who were tested are given at the end of this paper. In reviewing the data, it should be remembered that processes other than epenthesis, deletion, and substitution were not counted as errors in cluster faithfulness. For example, the production of the cluster in "konz" as [ns] was considered a case of devoicing rather than one of substitution. Thus, it was treated as a correctly produced cluster.

7.1 C + fricative clusters:

a. A high cluster faithfulness rate was predicted because of the final fricative present in the target words. To qualify as correct, the coda cluster had to be pronounced intact with no word-final epenthesis. The subjects' mean faithfulness rate for these clusters was 39.3%. The rate for the control was 86.7%.

b. A low rate of word-final epenthesis was predicted following intact C + fricative clusters because of the release already provided by the fricative in final position. The subjects' mean rate was 24.4%. The control's was 13.3%.

7.2 C + stop clusters:

a. A low cluster faithfulness rate was predicted because of the absence of a word-final continuant in the target words. Again, to be counted as correct, the cluster had to be pronounced intact with no word-final epenthesis. The subjects' mean faithfulness rate was 5.5%. The control's rate was 45%.

b. A high rate of epenthesis following intact clusters was predicted to provide subjects with a word-final continuant. The subjects' mean rate was 88.9%. The control's rate was 55%.

8 Discussion

Table 2
Cluster faithfulness (no epenthesis)

C + fricative clusters	Subject mean = 39.3% Control = 86.7%
C + stop clusters	Subject mean = 5.5% Control = 45%

As can be seen in Table 2, a significantly higher rate of cluster faithfulness occurred (with both the subjects and the control) for the C + fricative clusters than for the C + stop clusters. This was predicted because it was believed that subjects would have less difficulty correctly producing clusters that already ended in a continuant. Because 39.3% may not appear to represent a high rate of cluster faithfulness, it is important to reiterate that the subjects' native languages allow no final clusters. Therefore, what is significant here is the fact that the subjects had much greater difficulty producing final clusters that did not end in fricatives – a faithfulness rate of only 5.5%.

As should be expected, the control, whose native language does allow final clusters, had a much higher faithfulness rate than the subject mean for both cluster types. However, the control's results were consistent with those of the subjects in that C + fricative clusters were far easier to produce correctly (86.7%) than C + stop clusters (45%).

Table 3
Intact clusters + epenthesis

C + fricative clusters	Subject mean = 24.4% Control = 13.3%
C + stop clusters	Subject mean = 88.9% Control = 55%

The data in Table 3 refer to cases in which clusters were kept intact, but were followed by word-final epenthesis. As predicted, subjects epenthesized at a much lower rate for C + fricative clusters (24.4%) than for C + stop clusters (88.9%). At first glance, the subject mean of 24.4% for C + fricative clusters may seem high when it is considered that the target words already have a release provided by the fricative. However, it is important to note that for all but one case (19/20 or 95%) in which epenthesis follows a fricative, the fricative in question was either [v] or [z]; that is, the epenthesis occurred after *voiced* fricatives. The significance of this should not be understated. Although both voiced and voiceless fricatives are continuants and, therefore, provide the type of final release described in this paper, apparently there is more of a parallel between epenthesis and voiceless (as opposed to voiced) fricatives. It seems that this observation must be accounted for if any further studies of this type are to be conducted. Nevertheless, the data still strongly support the point that epenthesis after cluster-final fricatives is comparatively uncommon.

Epenthesis after cluster-final fricatives was also uncommon in the control's productions (13.3%). However, the rate for C + stop clusters was 55%. What is most significant here, of course, is the fact that the control violated cluster faithfulness *most of the time*, as did the subjects.

9 Conclusion

As was stated in the Introduction, the aim of this paper was to draw a parallel between the production of cluster-final fricatives and a tendency for epenthesis following C + stop clusters. In the process of exploring this parallel, the definition of epenthesis was broadened to include aspiration.

Essentially, two major predictions were made for this study, and it appears that both have turned out to be true. First, subjects made fewer errors in cluster production with C + fricative clusters than with C + stop clusters. Second, subjects epenthesized at a low rate after cluster-final fricatives and at a high rate after cluster-final stops. While a deeper analysis within the framework of the SSC could certainly be conducted with the data compiled in this study, the results seem to present an intriguing challenge to Broselow and Finer's Sonority Index. For this challenge to be stronger, however, similar results would have to be found using more clusters that end in fricatives other than [s] and [z], since these are already known to be common violators of the SSC in both onsets and codas.

Nevertheless, in view of the results of this study, it seems reasonable to claim that the subjects were generally consistent in their treatment of word-final clusters. That is, they consistently produced word-final continuants at a high rate – whether the continuant was already present in the cluster as a word-final fricative, or was added by the subject through epenthesis.

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APPENDIX A
Transcriptions

	S1 (Spanish)	S2 (Spanish)	S3 (Spanish)
konz	ko[nzə]	ko[ns]	ko[nzə]
sork	so[rk^{h}]	so[ɹk^{h}]	so[ɹk]
dast	da[st^{h}]	da[st^{h}]	da[st^{h}]
larf	la[rf]	la[f]	la[ɹf]
holp	ho[lp^{h}]	ho[lp^{h}]	ho[lp^{h}]
fips	fi[ps]	fi[ps]	fi[ps]
burz	bu[ɹzə]	bu[ɹs]	bu[ɹzə]
nild	ni[ldə]	ni[ldə]	ni[ld]
rict	ri[kə̥t^{h}]	ri[k^{h}]	ri[kət^{h}]
morp	mo[rp^{h}]	mo[p^{h}]	mo[ɹp^{h}]
gomz	go[mzə]	go[ms]	go[ms]
nept	ne[pt^{h}]	ne[pt^{h}]	ne[pt^{h}]
fets	fe[ts]	fe[ts]	fe[ts]
visk	vi[sk^{h}]	vi[sk^{h}]	vi[sk^{h}]
nudz	nu[dɪz]	nu[dəs]	nu[ts]
lefs	le[fsts]	le[fst^{h}]	le[fs]
tavz	ta[vəzə]	ta[f]	ta[vzə]
bimp	bi[mp^{h}]	bi[mpə]	bi[mp^{h}]
lunk	lu[ŋk^{h}]	lu[ŋkə]	lu[ŋk^{h}]
melf	me[lf]	me[lf]	me[lf]
tasp	ta[sp^{h}]	ta[spə]	ta[sp^{h}]
zarb	za[rbə]	za[ɹbə]	za[ɹbə]
valt	va[ltə]	va[lt^{h}]	va[lt]
lant	la[nt^{h}]	la[ntə]	la[nt]
folz	fo[lzə]	fo[ls]	fo[lzə]
nord	no[ɹdə]	no[ɹdə]	no[ɹdə]
tegz	te[gəzə]	te[kx]	te[gzə]
bift	bi[fə̥t^{h}]	bi[f]	bi[ft^{h}]
zoks	zo[kə̥s]	zo[ks]	zo[ks]
pulk	pu[lk^{h}]	pu[lk]	pu[lk^{h}]
lart	la[rt^{h}]	la[ɹt^{h}]	la[ɹt^{h}]
parg	pa[ɹgɪ]	pa[ɹx]	pa[ɹgə]

zelb	ze[ləbə]	ze[lbə]	ze[lbə]
lubz	lu[bɪzə]	lu[ps]	lu[bzə]
berv	be[ɹvə]	be[ɹf]	be[ɹvə]
	S4 (Japanese)	S5 (Japanese)	S6 (Japanese)
konz	ko[nzə]	ko[ns]	ko[nzə]
sork	so[kʰ]	so[kʰ]	so[kə]
dast	da[stʰ]	da[stʰ]	da[stʰ]
larf	la[f]	la[f]	la[f]
holp	ho[pə]	ho[lpʰ]	ho[pʰ]
fips	fi[pəts]	fi[ps]	fi[ps]
burz	bu[zə]	bu[s]	bu[s]
nild	ni[də]	ni[də]	ni[ldə]
rict	ri[kt]	ri[kətʰ]	ri[kə̥tə̥]
morp	mo[kʰ]	mo[pʰ]	mo[pʰ]
gomz	go[mzə]	go[məs]	go[ns]
nept	ne[pt]	ne[pətʰ]	ne[pətʰ]
fets	fe[ts]	fe[ts]	fe[ts]
visk	vi[skʰ]	vi[skʰ]	vi[skʰ]
nudz	nu[dzə]	nu[z]	nu[z]
lefs	le[fs]	le[fts]	le[fs]
tavs	ta[və̥z]	ta[fs]	ta[və̥zə]
bimp	bi[m]	bi[ps]	bi[mpʰ]
lunk	lu[ŋkə]	lu[ŋk]	lu[ŋkʰ]
melf	me[lf]	me[f]	me[f]
tasp	ta[spʰ]	ta[spʰ]	ta[spʰ]
zarb	za[bə̥]	za[bə]	za[bə]
valt	va[ltʰ]	va[tʰ]	va[ltə̥]
lant	la[ntʰ]	la[ntʰ]	la[ntə]
folz	fo[zə]	fo[ls]	fo[ls]
nord	no[də]	no[də]	no[tə]
tegz	te[gəzə]	te[gəs]	te[ns]
bift	bi[ftʰ]	bi[ftʰ]	bi[ftə]
zoks	zo[ks]	zo[ks]	zo[ks]
pulk	pu[kʰ]	pu[kʰ]	pu[ləkə̥]
lart	la[tʰ]	la[tʰ]	la[tə]

parg	pa[gə]	pa[gə]	pa[kə]
zelb	ze[bə]	ze[bə̥]	ze[bə]
lubz	lu[bə̥zə̥]	lu[bəs]	lu[bəs]
berv	be[və]	be[f]	be[f]

	S7 (Mandarin)	S8 (Mandarin)
konz	ko[ns]	ko[ns]
sork	so[kətə]	so[k^h]
dast	da[stə]	da[st^h]
larf	la[f]	la[f]
holp	ho[p]	ho[p^h]
fips	fi[ps]	fi[ps]
burz	bu[ts]	bu[s]
nild	ni[ldə]	ni[də]
rict	ri[kə̥t^h]	ri[kət^h]
morp	mo[pə]	mo[p^h]
gomz	go[mis]	go[mps]
nept	ne[p^h]	ne[ptə]
fets	fe[s]	fe[ts]
visk	vi[sk^h]	vi[sk^h]
nudz	nu[dɪs]	nu[z]
lefs	le[fs]	le[fs]
tavz	ta[vɪs]	ta[vs]
bimp	bi[mp^h]	bi[mp^h]
lunk	lu[ŋk^h]	lu[ŋk^h]
melf	me[f]	me[f]
tasp	ta[sp^h]	ta[sp^h]
zarb	za[p^h]	za[bə]
valt	va[t^h]	va[t^h]
lant	la[t^h]	la[nt^h]
folz	fo[t^h]	fo[s]
nord	no[də]	no[də]
tegz	te[ks]	te[ks]
bift	bi[f]	bi[ft^h]
zoks	zo[ks]	zo[ks]
pulk	pu[kə]	pu[k^h]

lart	la[tə]	la[tʰ]
parg	pa[kə̥]	pa[kə̥]
zelb	ze[pʰ]	ze[bə̥]
lubz	lu[ps]	lu[bəs]
berv	be[ve]	be[və]
	S9 (Indonesian)	S10 (Indonesian)
konz	ko[ns]	ko[ns]
sork	so[gə̥]	so[kə]
dast	da[s]	da[s]
larf	la[f]	la[f]
holp	ho[l]	ho[p]
fips	fi[s]	fi[ps]
burz	bu[s]	bu[s]
nild	ni[ldə]	ni[l]
rict	ri[ts]	ri[tʃ]
morp	mo[p]	mo[p]
gomz	go[mzə]	go[mps]
nept	ne[f]	ne[pʰ]
fets	fe[s]	fe[t]
visk	vi[s]	vi[sk]
nudz	nu[dzə]	nu[ts]
lefs	le[vzə]	le[f]
tavz	ta[zə]	ta[f]
bimp	bi[m]	bi[m]
lunk	lu[ŋk]	lu[ŋ]
melf	me[l]	me[f]
tasp	ta[s]	ta[ps]
zarb	za[bə]	za[p̚]
valt	va[l]	va[t̚]
lant	la[nt]	la[n]
folz	fo[ls]	fo[s]
nord	no[ɹtʰ]	no[t̚]
tegz	te[ks]	te[tʃ]
bift	bi[vzə]	bi[f]
zoks	zo[gs]	zo[ks]

pulk	pu[lkə]	pu[k^h]
lart	la[ɹtə]	la[t^h]
parg	pa[ɹgə]	pa[gə]
zelb	ze[bə]	ze[p̚]
lubz	lu[vzə]	lu[ps]
berv	be[və]	be[pf]

	Control (Am. English)
konz	ko[nz]
sork	so[ɹk]
dast	da[st^h]
larf	la[ɹf]
holp	ho[lp^h]
fips	fi[ps]
burz	bu[ɹz]
nild	ni[ld]
rict	ri[kt^h]
morp	mo[ɹp]
gomz	go[mz]
nept	ne[pt^h]
fets	fe[ts]
visk	vi[sk]
nudz	nu[dzə]
lefs	le[fs]
tavz	ta[vzə]
bimp	bi[mp^h]
lunk	lu[ŋk]
melf	me[lf]
tasp	ta[sp^h]
zarb	za[ɹb]
valt	va[lt]
lant	la[ntə]
folz	fo[lz]
nord	no[ɹd]
tegz	te[gz]
bift	bi[ft^h]

zoks	zo[ks]
pulk	pu[lkə]
lart	la[ɹt^h]
parg	pa[ɹg]
zelb	ze[lbə]
lubz	lu[bz]
berv	be[ɹv]

APPENDIX B
Cluster Faithfulness

I. C + fricative clusters
(1 = cluster maintained with no epenthesis; 0 = cluster not maintained)

Target	**S1 (Spanish)**	**S2 (Sp.)**	**S3 (Sp.)**	**S4 (Ja.)**	**S5 (Ja.)**
Konz	0	1	0	0	1
Larf	1	0	1	0	0
Fips	1	1	1	0	1
Burz	0	1	0	0	0
Gomz	0	1	1	0	0
Fets	1	1	1	1	1
Nudz	0	0	1	0	0
Lefs	0	0	1	1	0
Tavz	0	0	0	0	1
Melf	1	1	1	1	0
Folz	0	1	0	0	1
Tegz	0	0	0	0	0
Zoks	0	1	1	1	1
Lubz	0	1	0	0	0
Berv	0	1	0	0	0
	4/15 = 26.7%	10/15 = 66.7%	8/15 = 53.3%	4/15 = 26.7%	6/15 = 40%

Target	**S6 (Ja.)**	**S7 (Ma.)**	**S8 (Ma.)**	**S9 (In.)**	**S10 (In.)**	**(control)**
Konz	0	1	1	1	1	1
Larf	0	0	0	0	0	1
Fips	1	1	1	0	1	1
Burz	0	0	0	0	0	1
Gomz	0	0	0	0	0	1
Fets	1	0	1	0	0	1
Nudz	0	0	0	0	1	0
Lefs	1	1	1	0	0	1
Tavz	0	0	1	0	0	0
Melf	0	0	0	0	0	1
Folz	1	0	0	1	0	1
Tegz	0	1	1	1	0	1
Zoks	1	1	1	1	1	1
Lubz	0	1	0	0	1	1
Berv	0	0	0	0	0	1
	5/15 = 33.3%	6/15 = 40%	7/15 = 46.7%	4/15 = 26.7%	5/15 = 33.3%	13/15 = 86.7%

II. C + stop clusters

Target	S1 (Sp.)	S2 (Sp.)	S3 (Sp.)	S4 (Ja.)	S5 (Ja.)
Sork	0	0	1	0	0
Dast	0	0	0	0	0
Holp	0	0	0	0	0
Nild	0	0	1	0	0
Rict	0	0	0	1	0
Morp	0	0	0	0	0
Nept	0	0	0	1	0
Visk	0	0	0	0	0
Bimp	0	0	0	0	0
Lunk	0	0	0	0	1
Tasp	0	0	0	0	0
Zarb	0	0	0	0	0
Valt	0	0	1	0	0
Lant	0	0	1	0	0
Nord	0	0	0	0	0
Bift	0	0	0	0	0
Pulk	0	1	0	0	0
Lart	0	0	0	0	0
Parg	0	0	0	0	0
Zelb	0	0	0	0	0
	0/20 = 0%	1/20 = 5%	4/20 = 20%	2/20 = 10%	1/20 = 5%

Target	S6 (Ja.)	S7 (Ma.)	S8 (Ma.)	S9 (In.)	S10 (In.)	(control)
Sork	0	0	0	0	0	1
Dast	0	0	0	0	0	0
Holp	0	0	0	0	0	0
Nild	0	0	0	0	0	1
Rict	0	0	0	0	0	0
Morp	0	0	0	0	0	1
Nept	0	0	0	0	0	0
Visk	0	0	0	0	1	1
Bimp	0	0	0	0	0	0
Lunk	0	0	0	1	0	1
Tasp	0	0	0	0	0	0
Zarb	0	0	0	0	0	1
Valt	0	0	0	0	0	1
Lant	0	0	0	1	0	0
Nord	0	0	0	0	0	1
Bift	0	0	0	0	0	0
Pulk	0	0	0	0	0	0
Lart	0	0	0	0	0	0
Parg	0	0	0	0	0	1
Berv	0	0	0	0	0	0
	0/20 = 0%	0/20 = 0%	0/20 = 0%	2/20 = 10%	1/20 = 5%	9/20 = 45%

APPENDIX C
Intact Clusters + Epenthesis

I. C + Fricatives

1 = intact cluster + epenthesis; 0 = intact cluster + no epenthesis (faithfulness) OR cluster error

Target	**S1 (Sp.)**	**S2 (Sp.)**	**S3 (Sp.)**	**S4 (Ja.)**	**S5 (Ja.)**
Konz	1 / Intact	0 / Intact	1 / Intact	1 / Intact	0 / Intact
Larf	0 / Intact	0	0 / Intact	0	0
Fips	0 / Intact	0 / Intact	0 / Intact	0	0 / Intact
Burz	1 / Intact	0 / Intact	1 / Intact	0	0
Gomz	1 / Intact	0 / Intact	0 / Intact	1 / Intact	0
Fets	0 / Intact	0 / Intact	0 / Intact	0 / Intact	0 / Intact
Nudz	0	0	0 / Intact	1 / Intact	0
Lefs	0 / Intact	0 / Intact	0 / Intact	0 / Intact	0
Tavz	0	0	1 / Intact	0	1 / Intact
Melf	0 / Intact	0 / Intact	0 / Intact	0 / Intact	0
Folz	1 / Intact	0 / Intact	1 / Intact	0	0 / Intact
Tegz	0	0	1 / Intact	0	0
Zoks	0	0 / Intact	0 / Intact	0 / Intact	0 / Intact
Lubz	0	0 / Intact	1 / Intact	0	0
Berv	1 / Intact	0 / Intact	1 / Intact	0	0
	*5/10 = 50%	0/11 = 0%	7/15 = 46.7%	3/7 = 42.9%	1/6 = 16.7%

* 10 clusters were produced intact. 5 out of these 10 had word-final epenthesis.

Target	**S6 (Ja.)**	**S7 (Ma.)**	**S8 (Ma.)**	**S9 (In.)**	**S10 (In.)**	**(control)**
Konz	1 / Intact	0 / Intact	0 / Intact	0 / Intact	0 / Intact	0 / Intact
Larf	0	0	0	0	0	0 / Intact
Fips	0 / Intact	0 / Intact	0 / Intact	0	0 / Intact	0 / Intact
Burz	0	0	0	0	0	0 / Intact
Gomz	0 / Intact	0	0	1 / Intact	0	0 / Intact
Fets	0 / Intact	0	0 / Intact	0	0	0 / Intact
Nudz	0	0	0	1 / Intact	0 / Intact	1 / Intact
Lefs	0 / Intact	0 / Intact	0 / Intact	1 / Intact	0	0 / Intact
Tavz	0	0	0 / Intact	0	0	1 / Intact
Melf	0	0	0	0	0	0 / Intact
Folz	0 / Intact	0	0	0 / Intact	0	0 / Intact
Tegz	0	0 / Intact	0 / Intact	0 / Intact	0	0 / Intact
Zoks	0 / Intact	0 / Intact	0 / Intact	0 / Intact	0 / Intact	0 / Intact
Lubz	0	0 / Intact	0	1 / Intact	0 / Intact	0 / Intact
Berv	0	0	0	0	0	0 / Intact
	1/7 = 14.3%	0/6 = 0%	0/7 = 0%	4/8 = 50%	0/5 = 0%	2/15 = 13.3%

C + stop clusters

Target	S1 (Sp.)	S2 (Sp.)	S3 (Sp.)	S4 (Ja.)	S5 (Ja.)
Sork	1 / Intact	1 / Intact	0 / Intact	0	0
Dast	1 / Intact	1 / Intact	1 / Intact	1 / Intact	1 / Intact
Holp	1 / Intact	1 / Intact	1 / Intact	0	1 / Intact
Nild	1 / Intact	1 / Intact	0 / Intact	0	0
Rict	0	0	0	0 / Intact	0
Morp	1 / Intact	0	1 / Intact	0	0
Nept	1 / Intact	1 / Intact	1 / Intact	0 / Intact	0
Visk	1 / Intact	1 / Intact	1 / Intact	1 / Intact	1 / Intact
Bimp	1 / Intact	1 / Intact	1 / Intact	0	0
Lunk	1 / Intact	1 / Intact	1 / Intact	1 / Intact	0 / Intact
Tasp	1 / Intact	1 / Intact	1 / Intact	1 / Intact	1 / Intact
Zarb	1 / Intact	1 / Intact	1 / Intact	0	0
Valt	1 / Intact	1 / Intact	0 / Intact	1 / Intact	0
Lant	1 / Intact	1 / Intact	0 / Intact	1 / Intact	1 / Intact
Nord	1 / Intact	1 / Intact	1 / Intact	0	0
Bift	0	0	1 / Intact	1 / Intact	1 / Intact
Pulk	1 / Intact	0 / Intact	1 / Intact	0	0
Lart	1 / Intact	1 / Intact	1 / Intact	0	0
Parg	1 / Intact	0	1 / Intact	0	0
Zelb	0	1 / Intact	1 / Intact	0	0
	17/17 = 100%	15/16 = 93.8%	15/19 = 78.9%	7/9 = 77.8%	6/7 = 85.7%

Target	S6 (Ja.)	S7 (Ma.)	S8 (Ma.)	S9 (In.)	S10 (In.)	(control)
Sork	0	0	0	0	0	0 / Intact
Dast	1 / Intact	1 / Intact	1 / Intact	0	0	1 / Intact
Holp	0	0	0	0	0	1 / Intact
Nild	1 / Intact	1 / Intact	0	1 / Intact	0	0 / Intact
Rict	0	0	0	0	0	1 / Intact
Morp	0	0	0	0	0	0 / Intact
Nept	0	0	1 / Intact	0	0	1 / Intact
Visk	1 / Intact	1 / Intact	1 / Intact	0	0 / Intact	0 / Intact
Bimp	1 / Intact	1 / Intact	1 / Intact	0	0	1 / Intact
Lunk	1 / Intact	1 / Intact	1 / Intact	0 / Intact	0	0 / Intact
Tasp	1 / Intact	1 / Intact	1 / Intact	0	0	1 / Intact
Zarb	0	0	0	0	0	0 / Intact
Valt	1 / Intact	0	0	0	0	0 / Intact
Lant	1 / Intact	0	1 / Intact	0 / Intact	0	1 / Intact
Nord	0	0	0	1 / Intact	0	0 / Intact
Bift	1 / Intact	0	1 / Intact	0	0	1 / Intact
Pulk	0	0	0	1 / Intact	0	1 / Intact
Lart	0	0	0	1 / Intact	0	1 / Intact
Parg	0	0	0	1 / Intact	0	0 / Intact
Zelb	0	0	0	0	0	1 / Intact
	9/9 = 100%	6/6 = 100%	8/8 = 100%	5/7 = 71.4%	0/1 = 0%	11/20 = 55%