# Appendix B: Effects of control predictors

The phonological control predictors enumerated in Appendix A operate as expected in our data, which we determined by treatment-coding them and making pertinent comparisons between levels. Deletion is most favored after /n/, significantly exceeding both sonorants (*β* = 0.35, *p* = 0.03) and obstruents (*β* = -0.29, *p* = 0.009), which do not significantly differ from one another (*β* = -0.07, *p* = 0.67). Where following segment is concerned, consonants that do not allow for resyllabification are the strongest promoters of deletion, followed by those that do (*β* = -0.76), pause (*β* = -1.51), and vowels (*β* = -1.93; all *p <* 0.001). These values were derived by setting nonresyllabifiable consonants as the reference level of following segment, but releveling the baseline to make all other logically possible comparisons reveals that all following environments significantly differ from one another at *p <* 0.001.

The predictor combining stress and syllable count finds significantly more deletion when a coronal stop cluster terminates a polysyllabic word of either stress pattern than when it terminates a monosyllabic word (stressed compared to mono: *β* = 0.37, *p* = 0.008; unstressed compared to mono: *β* = 0.68, *p <* 0.001). Within polysyllabic words, we find significantly more deletion when the coronal stop cluster terminates an unstressed syllable than a stressed one (*β* = 0.31, *p* = 0.03). To our knowledge, the role of syllable count in conditioning CSD is previously undocumented. Additionally, though the increased rate of CSD in unstressed syllables has been observed before (Guy, 1980; Labov, 1989), this predictor is rarely included in CSD research, but its effect in the present data set suggests that it should be. We also find significant favoring effects on CSD of higher word frequency (*β* = 0.16, *p* = 0.001) and increased speech rate (*β* = 0.21, *p <* 0.001) in the full dataset, again consistent with previous work (e.g., Jurafsky et al., 2001; Tanner et al., 2017).

For the most part, these same effects hold in the subset models discussed in the paper and presented in Appendix F. One notable exception is that frequency is a significant predictor in some but not all of the subset models. This is unsurprising in light of the fact that frequency has been reported to interact with grammatical category in CSD (Guy, 2019; Meyers & Guy, 1997). Accounting for when and why frequency does and doesn’t condition CSD across the more fine-grained set of grammatical contexts we delineate here would certainly be of interest, but is beyond the scope of the current paper. We set the question aside for future research and here treat frequency simply as a control predictor that we recognize may not capture all of the true frequency-related variance in the data.

# Appendix C: Token and type counts

Table A1. *Token and type breakdown of* -ed *forms (total* n *tokens = 3703)*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **preterite** | **perfect** | **eventive** | **pred. stative** | **attr. stative** |
| *n* tokens = | 2443 | 219 | 371 | 589 | 81 |
| *n* types = | 293 | 59 | 138 | 147 | 44 |

Table A2. *Token and type breakdown of non-*ed *forms, subdivided by morphological makeup and level of lexical phonology at which an item’s coronal stop cluster is introduced (total* n *tokens = 6778)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **L3** | **L2** | **L1** | **pre-L1** |
|  | *-est* | *-ist* | *-ment* | *-ant* | *-ent* | *-est* | *-ment* | *-t* | trulymono | compound | prefixed | ambig.prefixed | proper |
| *n* tokens = | 183 | 52 | 84 | 104 | 447 | 46 | 171 | 31 | 4087 | 381 | 10 | 1121 | 61 |
| *n* types = | 33 | 25 | 34 | 20 | 14 | 3 | 22 | 5 | 179 | 31 | 10 | 58 | 10 |

Table A3. *Token and type breakdown of non-*ed *forms, re-divided by morphological makeup and level of lexical phonology at which an item’s coronal stop cluster is introduced (total* n *tokens = 6778)*

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **L3** | **L2** | **L1** | **pre-L1** |
|  |  |  |  | truly mono | complex | ambig. prefixed | proper |
| N tokens = | 183 | 136 | 799 | 4087 | 391 | 1121 | 61 |
| N types = | 33 | 59 | 64 | 179 | 41 | 58 | 10 |

Appendix D: Categorization of non­*-ed* items

Non-*ed* items were categorized as having their consonant cluster introduced pre-L1, at L1, at L2, or at L3. Items that could not be classified with confidence were excluded. Here we enumerate which items went into which category, and which were excluded.

* The following types of unsuffixed forms have their coronal stop cluster introduced **pre-L1**:
	+ **Truly monomorphemic forms** (e.g., *blind, connect, frost, husband, plant*): These items have their coronal stop cluster present underlyingly, from the beginning of the derivation.
	+ **Compounds** (e.g., *airlift, housebound, playground, riverfront, seatbelt*) and prefixed forms (e.g., *befriend, react*): Like truly monomorphemic forms, these items also have their coronal stop cluster present underlyingly, from the beginning of the derivation. (Though the processes of compounding and prefixing occur at later levels, those processes do not introduce the coronal stop cluster which is the target of study here.)
	+ **Ambiguously prefixed forms** (e.g., *advent, almost, amount, convent, exact, invent, island*.): Though these forms end in a string resembling an English word (*vent, most, mount, act, land*), they are not transparently decomposable into a prefix and a stem (e.g., *exact* is not obviously *ex + act* in the synchronic grammar). They may be treated as prefixed synchronically, or they may be monomorphemic. But either way, these items will have their coronal stop cluster from the beginning of the derivation.
	+ **Etymologically compound proper nouns** (e.g., *Cleveland, Maryland, Richmond, Roosevelt, Vermont*): Köhnlein (2015) provided evidence that historically polymorphemic proper nouns like these can behave phonologically as if they were still polymorphemic, despite not being semantically decompositional to contemporary speakers. There is thus a possibility that these items should be treated as compound, despite not obviously being derived synchronically. Whether they are compound or monomorphemic, though, these items will have their coronal stop cluster from the beginning of the derivation. Accordingly, they are also assigned the level **pre-L1**.
* Suffixed forms ending in any of the following suffixes have their coronal stop cluster introduced at **L1**:
	+ ***-ant***, when attaching to stems (e.g., *consultant, malignant*) or deriving adjectives and nouns from verbs (e.g., *hesitant, migrant*) (Kiparsky, 1982:7, 24, Mohanan, 1986:22)
	+ ***-ent***(e.g., *excellent, referent*) (Kiparsky, 1982:12, 38, Mohanan, 1986:18). The *-ent* suffix isn’t discussed explicitly in the lexical phonology literature, but it bears the hallmarks of a L1 suffix, shifting stress (e.g., *excél/éxcellent*) and inducing trisyllabic shortening (e.g., *r[i]fer/r[*ɛ*]ferent*, Kiparsky, 1982:38).
	+ **Superlative *-est***, in the forms *youngest, longest, strongest* only (Halle & Mohanan, 1985:63).
	+ ***-ment***, when attaching to bound stems (e.g., *compliment, experiment*) or making a semantically opaque form (e.g., *basement, apartment*) (Kiparsky, 1982:86, fn. 13). Kiparsky differentiated between L1 *-ment*, which makes semantically opaque forms, and L2 *‑ment*, which makes semantically transparent ones. We consulted the context of all the *-ment* forms in our data to see whether they were being used in a semantically opaque way (e.g., *assignment* as in homework assignment, *appointment* as in doctor’s appointment) or a semantically transparent way (e.g., *assignment* as in the assigning of someone to a position, *appointment* as in the appointing of someone to a position), and coded their level as appropriate.
	+ **Nominalizer *-t***(e.g., *complaint, extent, gift*). This specific *-t* suffix is not discussed in the literature, but other *-t* suffixes (e.g., the one that creates *theft* from *thief*) are placed at L1 (Mohanan, 1986:41). It is an open question whether *gift* is synchronically derived from *give*; we assume here that it is, but targeted empirical work will be necessary to confirm this. With only 15 tokens, this particular lexical item is likely not strongly influencing the results.
* Suffixed forms ending in any of the following suffixes have their coronal stop cluster introduced at **L2**:
	+ ***-ist***(e.g., *artist, linguist, scientist*) (Kiparsky, 1982:5).
	+ ***-ment***, when making a semantically transparent form (Mohanan, 1986:44, 57, and see note on L1 *-ment* above).
* Suffixed forms ending in the following suffix have their coronal stop cluster introduced at **L3**:
	+ **Superlative *-est***, in all forms besides *youngest, longest, strongest* (Kiparsky, 1982:5).
* The following categories of items were **excluded**, because their morphological makeup is ambiguous in a way that makes them impossible to localize to a given level:
	+ **Suppletive superlatives** (*best, first, last, least, most, worst*): The lexical phonology literature does not comment on these items. In some ways they are reminiscent of L1 *-est*-suffixed forms, but in other ways they are reminiscent of monomorphemes. We exclude them absent any evidence that they are synchronically compositional.
	+ **Ambiguously suffixed forms** (e.g., *lenient, permanent, opponent, recipient*): These forms plausibly end in a productive English suffix (e.g., *-ent*), but either the stem is bound (as in *lenient*) or the suffixed version of the stem is irregularly phonologically related to the isolated form of the stem (as in *opponent*). If these items are truly decomposable as a stem plus a suffix, they need to be attributed to the appropriate level of suffixation. But if speakers instead treat them as monomorphemic, they need to be identified with the other pre-L1 forms. Absent evidence either way, we exclude these items from study. Targeted experimental work will likely be necessary to reveal the morphological structure of these items.

Appendix E: Table exemplifying the Exponential Model

Table A4 schematizes the derivation of seven lexical items and calculates the predicted rates of CSD application for each under the Exponential Model. We assume three levels of affixation, as in Kiparsky (1982) and others cited above; where this differs from Guy’s (1991) model, this is indicated. In this toy example, each word is represented by 100 tokens, all of which are initially coronal stop-final. CSD applies at a stable rate of 0.25 before L1 affixation and again after each level. As the words progress through multiple rounds of CSD, the number of coronal stop-final tokens diminishes. The number of coronal stop-final tokens for a given word at a given point in the derivation is indicated in parentheses.

Table A4. *Sample rates of CSD by level of coronal stop attachment under a generalized version of Guy’s (1991) Exponential Model. We exemplify the model with 100 tokens of each word and a stable CSD rate of 0.25 applying before L1 affixation and again after each level. Ns in parentheses indicate how many coronal stop-final tokens remain after each round of CSD*

|  |  |
| --- | --- |
|  | **Sample derivations** (initial *n* = 100 for all) |
| **Level of CS attachment** | *mist* | *lost* | *strongest* | *artist* | *missed* | *smallest* |
| underlying form (pre-L1) | mist | lose | strong | art | miss | small |
| *(CSD applies at a rate of 0.25)* | mist (*n* = 75) | n/a |
| L1 | mist | los-**t** | strong-**est** | art | miss | small |
| *(CSD applies at a rate of 0.25)* | mist (*n* = 56) | lost (*n* = 75) | strongest (*n* = 75) | n/a |
| L2 (not present in Guy) | mist | lost | strongest | art-**ist** | miss | small |
| *(CSD applies at a rate of 0.25)* | mist (*n* = 42) | lost (*n* = 56) | strongest (*n* = 56) | artist (*n* = 75) | n/a |
| L3 (Guy’s L2) | mist | lost | strongest | artist | miss-**ed** | small-**est** |
| *(CSD applies at a rate of 0.25)* | mist (*n* = 31) | lost (*n* = 42) | strongest (*n* = 42) | artist (*n* = 56) | missed (*n* = 75) | smallest (*n* = 75) |
| number of applications of CSD | 4 | 3 | 3 | 2 | 1 | 1 |
| overall rate of CSD application | 0.69 | 0.58 | 0.58 | 0.44 | 0.25 | 0.25 |

# Appendix F: Outputs of statistical models

Table A5. *Baseline model. Morphological class is treatment-coded with non-*ed *as the reference*

*level*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Estimate | z | *Pr*(*>* |*z*|) |  | *n* | % deleted |
| intercept | 0.07 | 0.69 | 0.49 |  | 10481 | 44 |
| **Predictors of interest** |  |  |  |  |  |
| morphological class (vs. non-*ed* word) |  | (non-*ed*) | 6778 | 54 |
| *-ed* word | -0.68 | -6.30 | *<* 0*.*001 |  | 3703 | 26 |
| **Control predictors** |  |  |  |  |  |
| preceding segment (vs. mean) |  | (sonorant) | 1355 | 42 |
| /n/ | 0.21 | 2.74 | 0.01 |  | 4660 | 55 |
| Obstruent | -0.08 | -1.07 | 0.29 |  | 4466 | 33 |
| following segment (vs. mean) |  | (vowel) | 3719 | 29 |
| Unsyllabifiable consonant | 1.05 | 23.32 | *<* 0*.*001 |  | 2804 | 68 |
| Syllabifiable consonant | 0.29 | 4.72 | *<* 0*.*001 |  | 969 | 56 |
| Pause | -0.46 | -10.11 | *<* 0*.*001 |  | 2989 | 36 |
| stress/syllable count (vs. mean) |  | (monosyll.) | 6308 | 36 |
| Polysyllable, stressed | 0.02 | 0.19 | 0.85 |  | 1686 | 57 |
| Polysyllable, unstressed | 0.33 | 4.43 | *<* 0*.*001 |  | 2487 | 55 |
| scaled log frequency | 0.16 | 3.26 | 0.001 |  |  |  |
| normalized speech rate | 0.22 | 8.06 | *<* 0*.*001 |  |  |  |
| Random intercepts: Word (SD = 0.72), Speaker (SD = 0.48) |

Table A6. *Model for -*ed *words. Morphosyntactic category is treatment-coded with preterite as the reference level*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Estimate | z | *Pr*(*>* |*z*|) |  | *n* | % deleted |
| intercept | -0.69 | -4.50 | *<* 0*.*001 |  | 3703 | 26 |
| **Predictors of interest** |  |  |  |  |
| morphosyntactic category (vs. preterite) | (pret.) | 2443 | 22 |
| Perfect | -0.12 | -0.57 | 0.57 |  | 219 | 22 |
| Eventive | 0.24 | 1.35 | 0.18 |  | 371 | 26 |
| Pred. stative | 0.61 | 3.92 | < 0.001 |  | 589 | 37 |
| Attr. stative | 1.59 | 4.83 | < 0.001 |  | 81 | 63 |
| **Control predictors** |  |  |  |  |
| preceding segment (vs. mean) |  | (sonorant)  | 503 | 33 |
| /n/ | 0.24 | 1.73 | 0.08 |  | 432 | 34 |
| Obstruent | -0.13 | -1.26 | 0.21 |  | 2768 | 23 |
| following segment (vs. mean) |  | (vowel) | 1693 | 08 |
| Unsyllabifiable consonant | 1.26 | 15.38 | < 0.001 |  | 856 | 55 |
| Syllabifiable consonant | 0.63 | 5.53 | < 0.001 |  | 279 | 42 |
| Pause | -0.21 | -2.41 | 0.02 |  | 875 | 25 |
| stress/syllable count (vs. mean) |  | (monosyll.) | 2894 | 22 |
| Polysyllable, stressed | 0.21 | 1.60 | 0.11 |  | 361 | 36 |
| Polysyllable, unstressed | 0.19 | 1.45 | 0.15 |  | 448 | 40 |
| scaled log frequency | 0.21 | 2.67 | 0.01 |  |  |
| normalized speech rate | 0.32 | 5.87 | < 0.001 |  |  |
| Random intercepts: Word (SD = 0.56), Speaker (SD = 0.65) |

Table A7. *Model for pre-L1 non-*ed *words. Morphological makeup is treatment-coded with true monomorpheme as reference level*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Estimate | z | *Pr*(*>* |*z*|) |  | *n* | % deleted |
| intercept | -0.15 | 0.99 | 0.32 |  | 5660 | 54 |
| **Predictors of interest** |  |  |  |  |  |  |
| morphological makeup (vs. true monomorpheme) | (mono.) | 4087 | 50 |
| Ambig. prefixed | 0.03 | 0.11 | 0.92 |  | 1121 | 65 |
| Complex | 0.75 | 2.62 | 0.01 |  | 391 | 61 |
| Compound proper | 1.57 | 3.16 | 0.002 |  | 61 | 62 |
| **Control predictors** |  |  |  |  |  |
| preceding segment (vs. mean) |  | (sonorant) | 852 | 47 |
| /n/ | 0.35 | 3.24 | 0.001 |  | 3406 | 59 |
| Obstruent | -0.02 | -0.16 | 0.87 |  | 1402 | 46 |
| following segment (vs. mean) |  | (vowel) | 1799 | 44 |
| Unsyllabifiable consonant | 0.93 | 15.38 | *<* 0*.*001 |  | 1607 | 74 |
| Syllabifiable consonant | 0.12 | 1.56 | 0.12 |  | 570 | 60 |
| Pause | -0.39 | -6.58 | *<* 0*.*001 |  | 1684 | 44 |
| stress/syllable count (vs. mean) |  | (monosyll.) | 3396 | 48 |
| Polysyllable, stressed | -0.21 | -1.46 | 0.14 |  | 1312 | 63 |
| Polysyllable, unstressed | 0.32 | 2.62 | 0.01 |  | 952 | 64 |
| scaled log frequency | 0.38 | 4.72 | *<* 0*.*001 |  |  |
| normalized speech rate | 0.21 | 6.08 | *<* 0*.*001 |  |  |
| Random intercepts: Word (SD = 0.72), Speaker (SD = 0.50) |  |  |

Table A8. *Model restricting pre-L1 non-*ed *words to disyllables, to confirm that morphological differences in the pre-L1 subset are not artifacts of syllable count differences.* n *= 1722 truly monomorphemic and 291 complex; proper nouns excluded due to small token counts (only 36 disyllables). Morphological makeup is treatment-coded with true monomorpheme as the reference level. Since syllable count is controlled by restricting the data set, the combined final-stress-and-syllable-count predictor is replaced by a predictor which captures final syllable stress only*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Estimate | z | *Pr*(*>* |*z*|) |  | *n* | % deleted |
| intercept | -0.27 | -0.92 | 0.36 |  | 2013 | 65 |
| **Predictors of interest** |  |  |  |  |
| morphological makeup (vs. true monomorpheme) | (mono.) | 1722 | 66 |
| Complex | 0.88 | 2.85 | 0.004 |  | 291 | 59 |
| **Control predictors** |  |  |  |  |  |
| preceding segment (vs. mean) |  |  | (sonorant) | 22 | 27 |
| /n/ | 0.54 | 2.17 | 0.03 |  | 1434 | 73 |
| Obstruent | -0.08 | -0.32 | 0.75 |  | 557 | 46 |
| following segment (vs. mean) |  |  | (vowel) | 525 | 54 |
| Unsyllabifiable consonant | 0.79 | 7.63 | *<* 0*.*001 |  | 660 | 81 |
| Syllabifiable consonant | 0.33 | 2.29 | 0.02 |  | 225 | 75 |
| Pause | -0.41 | -4.12 | *<* 0*.*001 |  | 603 | 53 |
| stress (vs. mean) |  |  |  | (primary) | 1213 | 63 |
| Non-primary | 0.60 | 2.45 | 0.01 |  | 800 | 67 |
| scaled log frequency | 0.50 | 3.85 | *<* 0*.*001 |  |  |
| normalized speech rate | 0.31 | 4.91 | 0.004 |  |  |
| Random intercepts: Word (SD = 0.76), Speaker (SD = 0.57) |  |  |

Table A9. *Model for non-*ed *words. Morphological makeup is treatment-coded with true monomorpheme as the reference level*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Estimate | z | *Pr*(*>* |*z*|) |  | *n* | % deleted |
| intercept | -0.14 | -1.2 | 0.23 |  | 6778 | 54 |
| **Predictors of interest** |  |  |  |  |  |  |
| morphological makeup (vs. true monomorpheme) |  | (mono.) | 5208 | 53 |
| pre-L1, complex | 0.68 | 2.77 | 0.01 |  | 391 | 61 |
| pre-L1, proper | 1.27 | 2.76 | 0.01 |  | 61 | 62 |
| L1 suffix | -0.09 | -0.40 | 0.69 |  | 799 | 50 |
| L2 suffix | -0.03 | -0.11 | 0.91 |  | 136 | 42 |
| L3 *-est* superlative | 1.43 | 4.34 | *<* 0*.*001 |  | 183 | 78 |
| **Control predictors** |  |  |  |  |  |  |
| preceding segment (vs. mean) |  |  |  | (sonorant)  | 852 | 47 |
| /n/ | 0.34 | 3.41 | *<* 0*.*001 |  | 4228 | 57 |
| Obstruent | -0.03 | -0.30 | 0.77 |  | 1698 | 50 |
| following segment (vs. mean) |  |  | (vowel)  | 2026 | 46 |
| Unsyllabifiable consonant | 0.90 | 16.69 | *<* 0*.*001 |  | 1948 | 74 |
| Syllabifiable consonant | 0.16 | 2.31 | 0.09 |  | 690 | 61 |
| Pause | 0.54 | -10.16 | 0.01 |  | 2114 | 41 |
| stress/syllable count (vs. mean) |  |  | (monosyll.) | 3414 | 48 |
| Polysyllable, stressed | -0.19 | -1.67 | 0.09 |  | 1325 | 63 |
| Polysyllable, unstressed | 0.31 | 2.80 | 0.01 |  | 2039 | 59 |
| scaled log frequency | 0.27 | 2.76 | 0.01 |  |  |
| normalized speech rate | 0.18 | 5.76 | *<* 0*.*001 |  |  |
| Random intercepts: Word (SD = 0.72), Speaker (SD = 0.48) |  |  |

Table A10. *Model restricting non-*ed *words to those with unstressed /st/ clusters: L3 -*est *superlatives (*n *= 183) and true monomorphemes ending in unstressed /st/, such as forest, honest, and interest (*n *= 68), to confirm that the high superlative -*est *deletion rate is not an artifact of its phonology. Morphological makeup is treatment-coded with true monomorpheme as the reference level. Since final syllable stress is controlled by restricting the data set, the combined final-stress-and-syllable-count predictor is replaced by a predictor which captures syllable count only (a continuous measure). Since preceding segment is controlled by restricting the data set, this predictor has been removed. The word random intercept was removed from this model because it had a variance of 0*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Estimate | z | *Pr*(*>* |*z*|) |  | *n* | % deleted |
| intercept | 0.65 | 0.19 | 0.85 |  | 251 | 69 |
| **Predictors of interest** |  |  |  |  |  |  |
| morphological makeup (vs. true monomorpheme) |  | (mono.) | 68 | 46 |
| L3 *-est* superlative | 1.20 | 2.52 | 0.01 |  | 183 | 78 |
| **Control predictors** |  |  |  |  |  |
| following segment (vs. mean) |  |  | (vowel) | 57 | 39 |
| Unsyllabifiable consonant | 2.93 | 3.67 | *<* 0*.*001 |  | 93 | 99 |
| Syllabifiable consonant | 0.68 | 1.18 | 0.24 |  | 31 | 87 |
| Pause | -1.38 | -3.28 | 0.001 |  | 70 | 47 |
| syllable count | -0.11 | -0.06 | 0.95 |  |  |  |
| scaled log frequency | -0.32 | -1.24 | 0.21 |  |  |  |
| normalized speech rate | 0.40 | 1.64 | 0.10 |  |  |  |
| Random intercept: Speaker (SD = 1.01) (Word intercept removed because SD was 0) |