Educational attainment and the retreat from the Philadelphia short-a system  
  
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**Introduction**

**Short-a in Philadelphia**

In Early Modern English, short-a underwent irregular lengthening and tensing before the voiceless fricatives /f, θ, s/ and nasals /m, n/; reflexes of this pattern are present in Mid-Atlantic dialects of American English as well as in various British dialects (see Wells 1982:203f.). Labov (1981) argues that the distribution of the tense and lax phonemes in the Mid-Atlantic is no longer governed by allophonic rules, but rather is the product of a complex phonemic split. In addition to the existence of several minimal pairs (e.g., the lax modal auxiliary *can* vs. the tense noun *can*), Payne (1980) finds that children born out-of-state who move to the Philadelphia metropolitan area fail to acquire the local short-a distribution, though they participate fully in other regional sound changes, which are largely allophonic or phonologically unconditioned.

Ferguson (1972) provides one of the first descriptions of the rules underlying the traditional Philadelphia split short-a system. Ferguson's research was carried out between 1940 and 1960, and is based on his own native speaker intuition, supplemented by natural observation and judgments from informants, mostly young men who attended the University of Pennsylvania. Ferguson first defines the phonetic quality of the two phonemes which make up the split system, noting that (æ) is low, front, unrounded, monophthongal---essentially of the same quality as most other varieties of English---while (æh) by contrast is diphthongal, and can be raised to [ɛə] or [eə]. As to the general rule governing which phoneme surfaces, Ferguson gives:

(1) The “traditional” pattern (after Ferguson 1972:262):  
  


Ferguson identifies numerous exceptions to this rule. For instance, there are two main categories of lexical items which have the lax phoneme rather than the tense phoneme predicted by (1): the verbs *am, can, ran, began, hast,* and *hath,* and the “learned words” such as *aft, crass, daft, damsel, gaffe, lass,* and *wrath* (264). Conversely, the “adjectives of emotion” *mad, bad,* and *glad* have the tense phoneme even though following [d] is not a regular tensing environment (263). In addition to these lexical exceptions, there are three classes of morphophonological exceptions. First, words like *passing* and *classes*, which fail to meet the conditions of (1) due to the addition of inflectional suffixes (the progressive/future/gerund suffix /-ɪŋ/, the noun plural suffix /-z/, the third-person singular active indicative agreement suffix /-z/, the regular past/past participle suffix /-d/, and perhaps the agentive   
/-ɚ/) are tense; Ferguson calls this the “preservation of stem identity”. On the other hand, tensing does not occur when the context in (1) is met due to shortening (*math*, *exam*) or schwa-elision (*family, camera*, *Catholic*)*.* Finally, according to Ferguson, short-a is not tense in an initial stressed syllable when followed by *-sp, -sf,* or *-sb* (*aspirin, asphalt, asbestos*).

Labov (1989, 1994) builds on Ferguson's description, formalizing additional rules and investigating possible exceptions using data from LCV, a corpus of sociolinguistic interviews collected in Philadelphia between 1973 and 1977. Whereas Ferguson's rule (1) requires that a tensing consonant be word-final or followed by another consonant, Labov specifically refers to a requirement that the tensing consonant is tautosyllabic (1994: 430). The result is that tensing is limited to closed syllables. He adds that the addition of inflectional suffixes does not affect the distribution of the tense and lax phonemes, whereas there is extensive variation associated with derivational suffixes.Labov also finds variation when short-a is followed by /st/ clusters (*master, plaster*), and observes possible extension of tensing to contexts where short-a is followed by nasal-vowel or lateral-vowel sequences such as *planet* or *personality* (1994: 433). He finds that the exceptional status of *mad, bad, glad* is truly lexical, citing the contrast of tense *bad* with lax *badminton*, and tense *glad* with lax *Gladstone* (1989: 17).

**Materials and methods**

We employ a data-driven approach to the coding of the Philadelphia short-a system, similar to that in Labov 1989. The data is comprised of 301 white adult speakers from the Philadelphia Neighborhood Corpus (Labov et al. 2013). Vowel tokens were automatically measured using FAVE version 1.1.3 (Rosenfelder et al. 2014).

Both authors visually inspected plots for each speaker, and speakers were excluded from the recoding process if there was consensus that the speaker did not conform to the traditional Philadelphia system as described above. Furthermore, speakers were excluded from this process if they did not produce at least five tokens of both the tense and lax variants. In all a subset of 229 speakers provided the data used to improve short-a coding.

Unstressed function words, which are often significantly reduced, were excluded from analysis, using a list from Selkirk 1984 (352-352). Similarly, this analysis was restricted to primary-stress tokens only. Formant measurements were converted from Hertz to Mel (Stevens and Volkmann 1940), and then normalized using the speaker-intrinsic, vowel-extrinsic Lobanov method. Mel space is used by phoneticians to better represent non-linearities in human speech perception.[[1]](#footnote-2) The combination of the Mel transform and Lobanov normalization allows us to better represent perceived frequencies, while also controlling for physiological differences between speakers.

The recoding process then proceeded in two steps, which are described separately below.

**x.1 Testing the ‘variable’ class**

FAVE-extract currently assigns a number of words in different phonological environments to a ‘variable’ short-a class, coded (aeBR). This class is a catch-all of lexical exceptions and potential change in progress identified at various points in the literature on short-a, which includes:

1. Words in which the short-a tensing segment is followed by a vowel (*Spanish, planet, damage*).
2. A subtype of (1) where the tensing segment is followed by a vowel due to the CMU dictionary pronunciation representing nasal cluster simplification (*grandmother, Atlantic, advantage*).
3. Previously identified lexical exceptions (*family, Catholic, ran*).
4. Words in which short-a is followed by /l/ (*Italian, pal, alley*).
5. Words in which short-a is followed by an /sC/ cluster (*basket, master, aspirin*).
6. Words that end in *–arry* (*Larry, Harry, marry*).

The frequencies of the subtypes of the (æBR) class in the 301-speaker subset of the PNC are given in Table 1.

[Table 1 about here]

The goal of the first step was to test whether the words that FAVE currently codes as ‘variable’ are truly variable, or can be reliably coded into the tense or lax class. For each speaker, we calculated the Mahalanobis distances in F1, F2 space between each (æBR) token and the speaker’s (æ) and (æh) means. Mahalanobis distance was chosen over Euclidean distance, as it takes into account correlations between F1 and F2.[[2]](#footnote-3) Each (æBR) token was then recoded according to whether it was closer to the tense or lax mean. Finally, we tabulated how often each (æBR) word was coded as tense or lax. If there were at least five tokens of the word, and the ratio of one code to the other was at least 2:1, then the word was recoded accordingly.

{Analysis of previous variable class here??}

These new codes were incorporated into a new short-a module for FAVE. This module includes several coding improvements: it uses a syllabification procedure (Gorman 2013) to accurately account for the tautosyllabicity constraint, and uses the Porter (1980) stemmer to detect resyllabification of a stem-final consonant due to the addition of the suffixes *-ed*, *-es*, and -*ing.* This reflects the “preservation of stem identity” governing the short-a distribution. Additionally, this module codes all short-a tokens, whereas FAVE only codes tokens with primary stress and marks all other tokens as lax.

[Figure 1 about here]

**x.2 Checking for new lexical exceptions**

***Coding Improvements***

*What does standard FAVE do?*

* *Only codes vowels with primary stress*
* *Tense if followed by word-final or pre-consonantal [M N S TH F] (man, ham; hand, classroom)*
* *Codes as "variable" if followed by tenser + non-suffix (-ing,-es) vowel*
  + *Attempt to account for tautosyllabicity without syllabification?*
* *Variable by stipulation:*
  + *Lexical exceptions: math, ran, swam, began, can, family, January, annual, Anne, Joanne, gas, exam, alas, aspirin, Catholic(s), camera*
  + *following /l/*
  + *sC clusters*
* *Tense by stipulation:*
  + *mad, bad, glad and some derived forms*
* *Not yet handled programmatically: errors caused by multiple pronunciations in CMU dict: schwa-apocope (camera), deletion (Santa, grandmother), weirdness (Africa). The most frequent instances of these currently in the corpus have been coded as exceptions to account for this.*

**Analysis of previous variable class categories**

**Tenser + V**

This category no longer exists per se, its members are handled by the syllabification script.

**Lexical exceptions**

These are checked against corpus data and reassigned as necessary.

**Following /l/**

These are coded as lax per orig. desc. In light of Dinkin's work however, researchers using this coding may wish to exclude pre-lateral tokens from analysis.

**Clusters**

Labov 1989 on sC clusters: “These words are normally pronounced with short *a* in an open syllable; otherwise, the stop would be aspirated, which is rarely the case. Syllable structure in the physical sense is not the governing parameter here; rather it is the abstract structure of the word.” [p 24] → see SPE, Vaux, etc on using aspiration as diagnostic of syllable structure. Also Occam's razor → it would be exceptional for short-a in an open syllable to tense in just these words, simplest explanation is that S is in coda.

For s-clusters analysis: 180 speakers from the Philadelphia Neighborhood Corpus (PNC) with clear traditional split short-a system. Yielded a total of 558 tokens of medial sC clusters (where C is [p t k]) following a short-a. For each token we calculated the Mahalanobis distance between it and the speaker's tense and lax short-a means, then coded the token as tense or lax according to which mean it was closer to. Coded tokens were plotted and visually inspected to insure that there were no gross errors in categorization. Finally, these codes were tabulated by word (given in the appendix), using the rule of thumb that words must have at least five tokens to be included (given two equally-probable outcomes, the probability of five instances of the same outcome occurring is .03125), and words are considered truly variable if there are not at least twice as many tokens coded in one class as there are in the other.

from which we may draw the following generalizations:

* SP clusters in this sample promote a lax short-a – only one token of *aspirin* in 28 SP cluster tokens was coded as tense
* ST and SK clusters are majority tense, with a few exceptions: *fantastic, plastic, astronaut, rascal,* and possibly *Alaska. Asteroid* and *elastic* may also fall into this category, but there are too few tokens to be sure. → learned words discussion?
* Thus it would appear that in ST and SK clusters, Philadelphians are analyzing the S as a coda consonant, and tensing short-a due to the tautosyllabic S. More data on SP clusters is needed, but the results here suggest that they behave differently, with S analyzed in the onset of the following syllable, thus not causing short-a tensing.

So what went into our short-a coding is: S is syllabified in coda, so normally coded as tense, with the lexical exceptions *aspect*, *aspirin*, *rascal,* which are lax, and *plastic, Alaska, fantastic* which are variable.

**CMU error**

Impossible to catch all of these without manually fixing the dictionary; most frequent affected words currently in the corpus have been hard-coded as exceptions in the relevant category.

***-arry* words**

Coded as lax per Labov.

**Results**

**Conclusions**

**Appendix**

List of short-a words included in cluster analysis and Mahalanobis distance categorization:

*Threshold for classification: at least 5 tokens & a 2:1 difference*

**Word (lax) ae aeh**

ASPECT[S] 8 1

ASPIRIN 16 1

ASTERISK 4 1

ASTEROID[S] 5 0

**Word (tense) ae aeh** ALASKA[N] 1 6

ASK[ED/ING] 5 178

BASKET[S] 0 18

BASKETBALL 2 77

CASKET 0 5

DISASTER 0 7

DRASTICALLY 1 5

FAST[ER/EST] 1 13

LAST[ED/ING] 3 14

MASTER[‘S/S] 7 29

NASTY 2 11

PASTOR[‘S/S] 2 17

PLASTER 1 4

PLASTIC 1 9

TASKER 0 25

**Word (variable?) ae aeh** FANTASTIC[ALLY] 9 5

**TABLES**

Table 1: Frequency by type and token of the subtypes of the (æBR) class.

|  |  |  |
| --- | --- | --- |
| (æBR) frequency in short-a data: | 17% of 2,674 words (n=447) | 20% of 33,399 tokens (n=6,646) |
| **Condition** | **Type frequency** | **Token frequency** |
| Following vowel | 40% (n=181) | 20% (n=1,321) |
| Following /l/ | 33% (n=149) | 29% (n=1,914) |
| Following *s*C cluster | 15% (n=65) | 11% (n=716) |
| Lexical exceptions | 5% (n=23) | 34% (n=2,252) |
| CMU variation | 5% (n=22) | 3% (n=240) |
| *-arry* words | 2% (n=7) | 3% (n=203) |

**Figures**

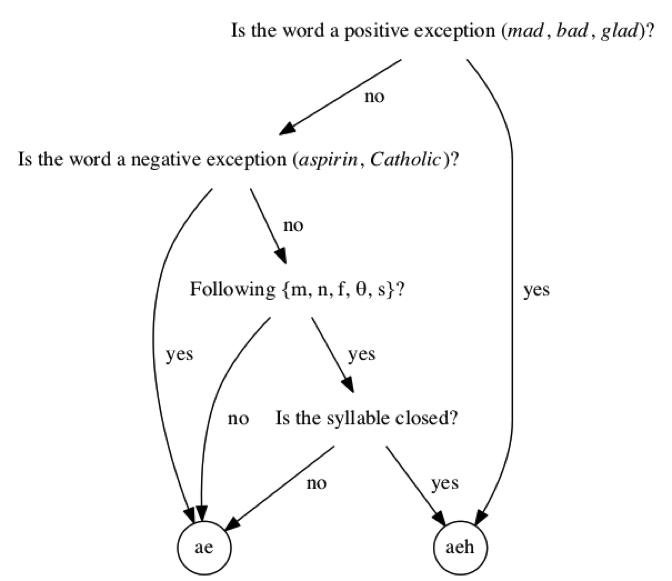


Figure 1: Proposed scheme for automated short-a coding.

1. Some researchers (e.g., Adank et al. 2004, Flynn 2011) also consider the Mel transform a form of vowel normalization. However, as Clopper 2009 (1432) points out, it is not truly a normalization algorithm, but rather a scale transformation that “more closely approximates human auditory processing.” Crucially, this transform does not minimize interspeaker variation due to physiological or anatomical differences, as it does not make use of any speaker-specific statistics. [↑](#footnote-ref-2)
2. These are likely to be particularly pronounced in the lower left corner of the vowel trapezoid, where vowel fronting demands concomitant vowel raising. [↑](#footnote-ref-3)