

Vowel Change across Noam Chomsky's Lifespan

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1 Introduction

This study seeks acoustic evidence for longitudinal vowel shifts in Noam Chomsky's speech between 1970 and 2009. It will show how his low back vowels /o/ and /oh/ and short-a have changed quantitatively as well as qualitatively over a 40-year period in Chomsky's public speech. Noam Chomsky is an ideal speaker for the study of long-term accent change not only because many of his interviews are readily available online but also because he relocated to a region characterized by a different dialect (Boston, MA) from his native dialect (Philadelphia, PA). The change in his accent, if any, can shed light on which phonetic and phonological variables an individual speaker can change over the course of their lifetime after relocation to a different dialect area.

2 The Speaker

Noam Chomsky was born in 1928 to Jewish parents in Philadelphia, Pennsylvania. His parents' first language was Yiddish, but Chomsky learned English as his first language. Chomsky belonged to a relatively high socioeconomic class. His family lived in the rich neighborhood of East Oak Lane, Philadelphia. His father was a professor of Hebrew at Gratz College. Graduating from the Central High School of Philadelphia, Chomsky began studying philosophy and linguistics at the University of Pennsylvania in 1945. He lived in Philadelphia until he received his doctoral degree in linguistics in 1955. Although he conducted part of his doctoral research at Harvard University, he lived in Philadelphia until the time he joined MIT in 1955. As of 2014, Chomsky has taught at MIT for 59 years and he resides in Lexington, Massachusetts.

3 Linguistic Variables

3.1 Low Back Vowels /o/ and /oh/

One major unconditioned merger attested in North America is the loss of contrast between the short-o (/o/) of *got*, *rock*, *top* etc., and long open-o (/oh/) in *law*, *talk*, *caught*, etc., which is often called the *cot-caught* merger (Labov et al. 2006). Figure 1 illustrates the geographic distribution of the areas where speech production of /o/ and /oh/ before /t/ are distinct, intermediate and merged.¹ As indicated by blue symbols through the North, North Midland and mid-Atlantic States including Philadelphia, /o/ and /oh/ are kept distinct in these areas. Therefore, Philadelphia speakers distinguish /o/ in *cot* from /oh/ in *caught*. By contrast, a high concentration of merged tokens (red symbols) can be found in Northeastern New England. Boston is a part of this area where the merger between /o/ and /oh/ predominates. In this area, speakers' production of *cot* and *caught* rhyme.

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¹The blue symbols represent speakers who have distinct /o/ and /oh/ while red symbols speakers who

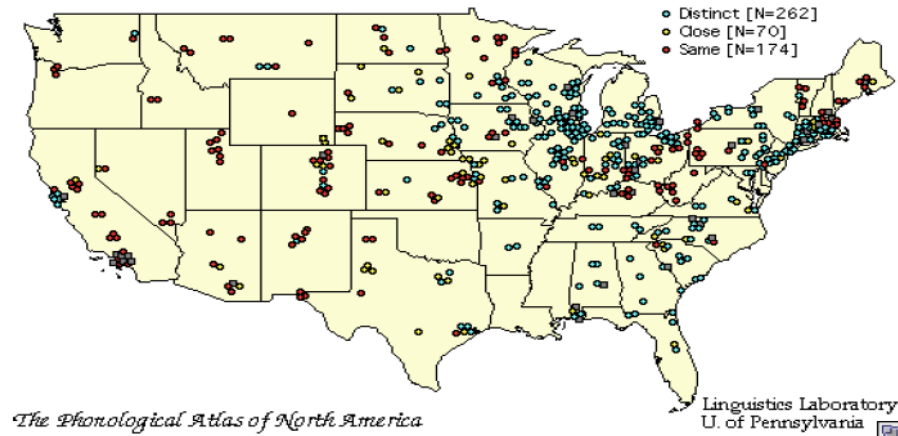


Figure 1: Geographic distribution of cot-caught merger.

3.2 Short-a

Philadelphia has a so-called split short-a system. In a split system, there is a phonemic distinction between tense /æh/ and lax /æ/. This distinction is subject to several phonological and lexical conditioning factors as follows: short-a is tense (raised, fronted and sometimes diphthongized) when followed by a tautosyllabic anterior nasal, a voiceless anterior fricative, or in three additional lexical items before /d/, *mad*, *bad*, and *glad* (Labov 1989, Labov et al. 2013, *inter alia*).

Boston, as a part of New England, is known to have a nasal short-a system. Unlike a split system, a nasal system shows discrete allophonic alternation between tense [æh] and lax [æ] with a simple allophonic rule: /æ/ becomes tense before nasals, regardless of syllabic or morphological status. The nasal system is perhaps the most widespread short-a system in North America, hence is regarded as a default American short-a pattern which occurs in disjoint and unrelated regions across the states (Labov et al. 2006).

4 Data

Two recordings of Noam Chomsky's public speech were chosen for the source of data. One is a recording of a talk titled *Government in the future* which was delivered at the Poetry Center of New York on February 16, 1970. The other recording is from the address titled *Crisis and hope: Theirs and ours* which Chomsky delivered at the Riverside Church in Harlem on June 12, 2009. Since stylistic differences can be a powerful conditioning factor, special attention was paid to choose two comparable speeches in terms of style. Both talks are highly formal and therefore are considered to have a comparable style of speech.

Two recordings were transcribed by the researcher and a forced alignment was produced with the transcriptions by using the FAVE (Forced Alignment and Vowel Extraction) program suite (Labov and Rosenfelder 2011), an adaptation of the Penn Phonetics Lab Forced Aligner (Yuan and Liberman 2008). Through these phonetic alignments, a total 10,178 of vowel tokens (4152 in 1970 and 6026 in 2009) were extracted and analyzed automatically. The vowel data in each recording were normalized using Lobanov normalization in order to factor out any physiological changes, possibly due to aging, and see only the linguistically meaningful changes. Table 1 shows the number of observations of two linguistic variables examined.

Year of recording	1970	2009
Data source	A public speech titled <i>Government in the future</i>	A public speech titled <i>Crisis and Hope: Theirs and Ours</i>
Number of all vowels	4152	6026
Number of low back vowels	392 (/o/: 245, /oh/: 147)	572 (/o/: 341, /oh/: 231)
Number of short-a ²	361	483

Table 1: Data sources and the number of tokens.

5 Low Back Vowels /o/ and /oh/

In this section, I attempt to answer two main questions. First, it will be examined if Chomsky's low back vowels /o/ and /oh/ show evidence of any significant shift over 40 years. Secondly, if there was any change, I show whether the change was a subphonemic shift or one that involved any phonological restructuring.

Figure 2 plots Chomsky's low back vowels /o/ and /oh/ in 1970 and 2009. There is a clear distinction between /o/ and /oh/ in 1970 and this distinction is maintained in 2009. Note, however, that his /o/ in 2009 is notably raised and backer compared to that of 1970 as can be clearly seen in the standard-deviation ellipses in Figure 3. Consequently, the two categories (/o/ and /oh/) are closer to each other in 2009 than in 1970. Let us now see if these impressionistic interpretations are confirmed by the statistical analyses.

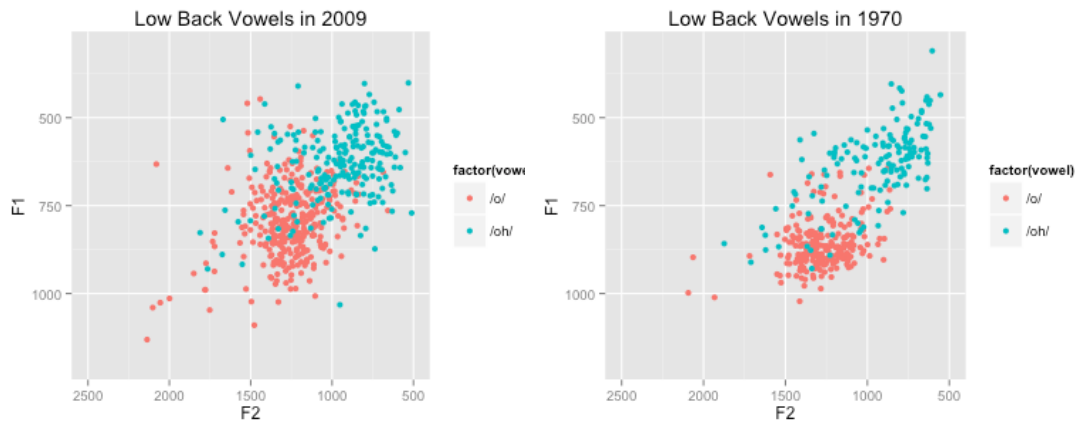


Figure 2: Chomsky's low back vowels /o/ and /oh/ in 1970 and 2009.

The shift of /o/ and /oh/ between 1970 and 2009? To see if there was a significant shift in Chomsky's low back vowels between 1970 and 2009, linear mixed model analyses were carried out on both F1 and F2 of /o/ and /oh/, respectively, to test if *Year* was a significant factor. Using `lmer()` function from the `lme4` package (Bates, Maechler and Bolker 2012) in R, a mixed effects model was fit to the F1 and F2 values of /o/ and /oh/ in Chomsky's speech in 1970 and 2009. The model shows that *Year* is a significant predictor for F1 (Estimate=-60.278, SE=8.459, $P < 0.0001$), suggesting that F1 of /o/ in 2009 is significantly lower than that in 1970. The mixed model on F2 of /o/ also selected *Year* as a significant predictor (Estimate=-147.22, SE=75.72, $P = 0.0525$),

²Of all tokens of short-a, three tokens of Bangladesh and four tokens of Iraq were excluded from the analysis because the first vowel in Bangladesh and the second vowel of Iraq was produced as /a:/ not /æ/. Hall-Lew et al. (2010) found that phonological variables can be a potential resource for the expression of political identity. They argued that Iraq's second vowel indexes political conservatism when produced as /æ/ and political liberalism when produced as /a:/ based on an analysis of the U.S. House of Representatives that Republicans are significantly more likely than Democrats to use /æ/, even controlling for regional accent.

showing that there was a significant change in F2 of /o/ between 1970 and 2009. The results from the mixed model on both F1 and F2 of /oh/, in contrast, show that *Year* is not a significant predictor, indicating that /oh/ has not shown any significant shift between 1970 and 2009.

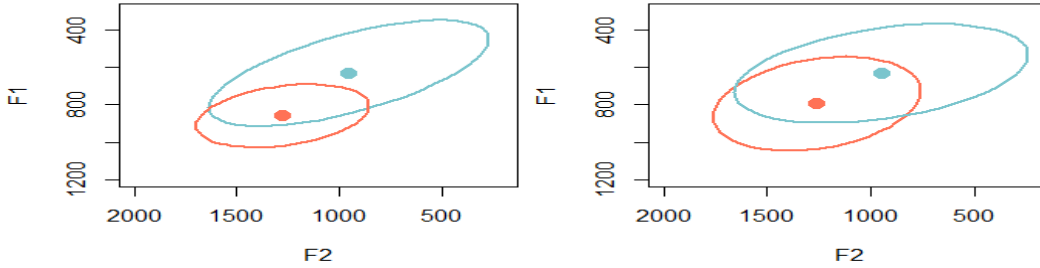


Figure 3: Standard-deviation ellipses around /o/ and /oh/ in the 1970 and 2009 recordings.

Changes in underlying representations? To see if the shift of /o/ between 1970 and 2009 led to the merger of two phonemes or not, it is examined whether there is significant differences in F1 and F2 of /o/ and /oh/ in 2009, respectively. The results of the mixed model on F1 and F2 of /o/ and /oh/ in 2009 show that /o/ and /oh/ have significant differences in the both F1 and F2 dimension ($p=4.15e-33$ for F1, $p=1.71e-16$ for F2), which reveals that /o/ and /oh/ still remain as two distinct underlying phonemes even after /o/ has significantly raised over 40 years.

The analyses thus far have shown that Noam Chomsky’s low back vowel /o/ has shifted significantly towards /oh/ in both F1 and F2 dimensions while his /oh/ remained largely unchanged. It was also shown that this change is a fine-grained phonetic shift not involving any phonological restructuring because there is no sign of a merger between two categories, even though the distance between /o/ and /oh/ is diminished as /o/ moves towards /oh/.

6 Short-a

In this section, I will explore how Chomsky’s short-a system has changed between 1970 and 2009. Two different types of plots are provided with two different assumptions: Chomsky 1) had the traditional Philadelphia split short-a system or 2) had the (national) default nasal short-a system prevalent in New England. As briefly discussed in Section 3, in the traditional split short-a system of Philadelphia, /æ/ is tense in syllables closed by coronal nasals (/n/, /m/), voiceless fricatives (/s/, /ʃ/, /f/) as well as in three words before /d/ (*mad, bad, glad*) (Labov et al. 2013, *inter alia*).

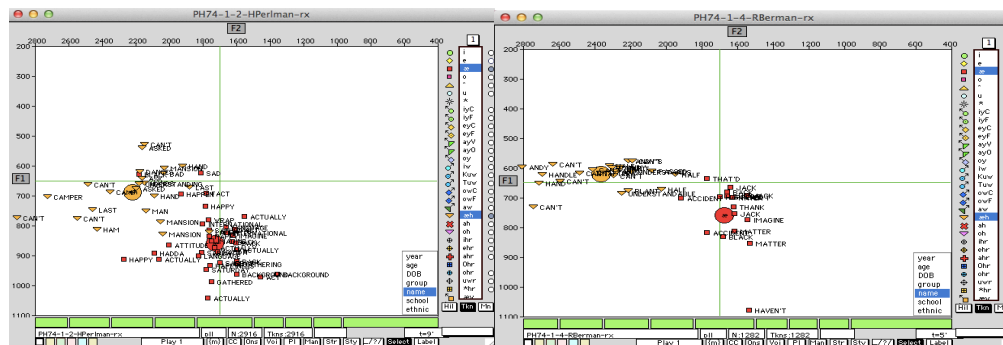
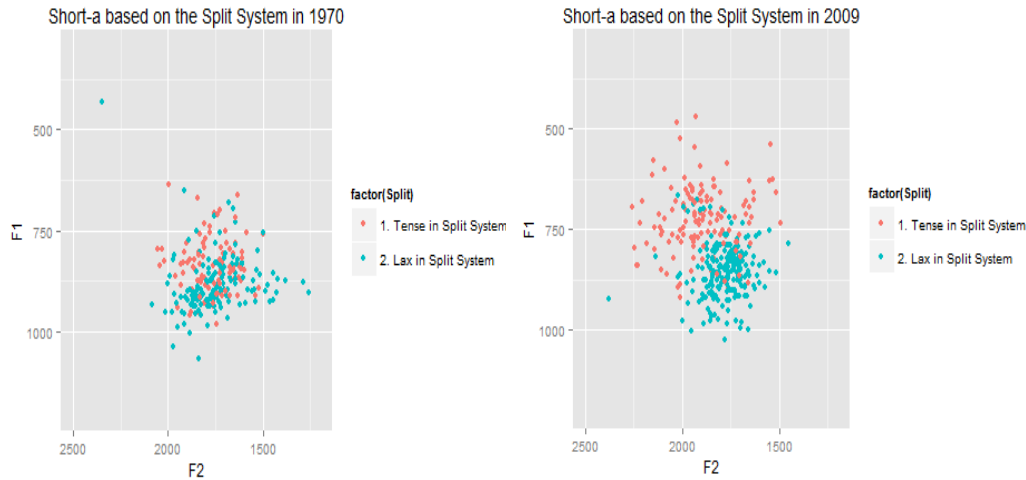


Figure 4: The Philadelphia split short-a system of two comparable speakers (H. Perlman and R. Berman) interviewed in 1974 from PNC.

Figure 4 displays very clear examples of a split system. Perlman and Berman, chosen from the Philadelphia Neighborhood Corpus (PNC) as comparable speakers to Noam Chomsky, were Jewish male speakers in their 40s or 50s when they were interviewed in 1974.³ Their short-a systems show that they have distinctly separate clusters for tense and lax phonemes.

In Figure 5, Chomsky's short-a vowels are plotted based on the phonological and lexical conditioning of a split system. The red dots represent the tokens of short-a that are normally tense in a split system, while the blue dots are those should be lax in a split system.



These are surprising pictures of Chomsky's short-a vowels if we expected he had a split system from the beginning. His short-a tokens in 1970 do not seem to show any split between tense /æh/ and lax /æ/. We can see almost all tokens that should be tense /æh/ in a split system (red dots) are within the cluster of lax /æ/. His short-a pattern in 2009 is more puzzling because he now has tense /æh/, although the boundary between the tense /æh/ and lax /æ/ is not distinct. The data from the 1970 and 2009 recordings reveal that it is hard to say that Chomsky had a perfect split system either in 1970 or 2009.

If Chomsky did not have a split system in 2009, another possible system he might have had is the nasal system because it is a more generalized North American pattern for short-a that is also prevalent in New England. In a nasal system, there are two discrete allophones: tense [æh] that appears before a nasal consonant and lax [æ] in all other environments. In Figure 6, Chomsky's short-a pattern is plotted based on a nasal system. Again, the red dots represent the tokens of short-a that should be tense in a nasal system (before a nasal), while the blue dots the tokens of short-a that should be lax in a nasal system (before a non-nasal).

We can see that his short-a pattern in 1970 does not fit into a nasal system either, because short-a tokens followed by a nasal that should be fronted and raised in a nasal system (red dots) are within the boundary of lax [æ]. Meanwhile, his short-a pattern in 2009 resembles that of a nasal system: although there is a moderate degree of overlap, we can see a tendency for prenasal short-a (red dots) to be in an upper mid position in the phonetic space while non-prenasal ones occupy low position (blue dots). Strictly speaking, however, it is not quite a nasal pattern that has a clear boundary between tense [æh] and lax [æ] allophones.

³Noam Chomsky was 42 years old at the time of giving the talk in 1970.

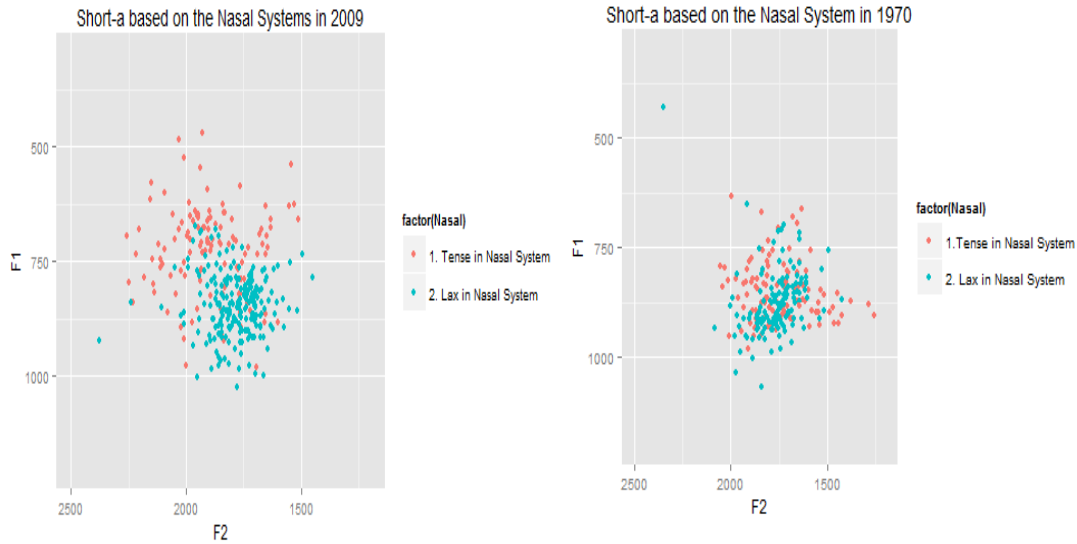


Figure 6: Chomsky's short-a distribution in 1970 and 2009 based on a nasal system.

Let us look into the change in the distribution more closely by looking at his short-a distribution by different environments: 1) before tautosyllabic anterior nasals (tense in both a split and a nasal system), 2) before velar nasal /ŋ/, nasals in open syllables (lax in a split system but tense in a nasal system), 3) before voiceless fricatives and in three lexical items *bad*, *mad*, *glad* (tense in a split system but lax in a nasal system) and 4) before stops (lax in both a split and a nasal system).

Figure 7 shows the distribution of short-a before tautosyllabic anterior nasals (tense in both a split and a nasal system) in 1970 and 2009. You can see that short-a before tautosyllabic anterior nasals in 2009 is noticeably more raised and fronted than that of 1970.

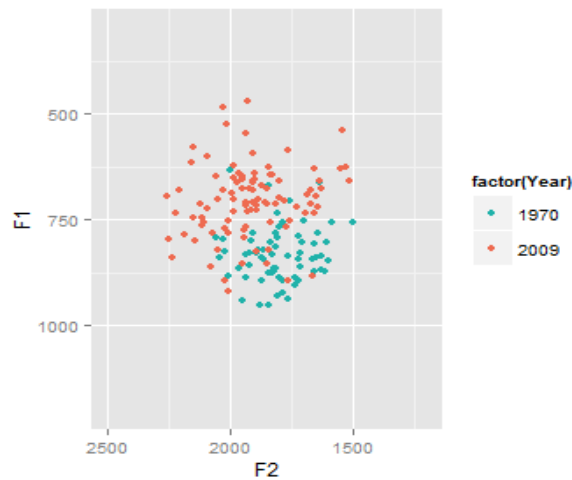


Figure 7: Short-a before tautosyllabic anterior nasals in 1970 and 2009 (tense in both a split and a nasal systems).

Figure 8 shows tokens of short-a before velar nasal /ŋ/, or nasals in open syllables that are lax in a split system but tense in a nasal system. In these environments, there is no significant change between 1970 and 2009. This suggests that he has not perfectly learned the distribution of tense [æh] before velar nasals and nasals in open syllables of a nasal system.

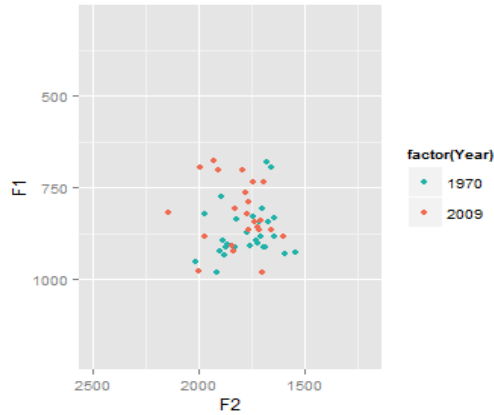


Figure 8: Short-a before velar nasals or nasals in open syllables in 1970 and 2009 (lax in a split system but tense in a nasal system).

Then what happened to short-a before voiceless fricatives and in the three lexical items *bad*, *mad*, *glad* that are tense in the split system but lax in the nasal system? In Figure 9, we can see that Chomsky's short-a in this environment fronted and raised a little over the forty year span. Note, however, that the shift was within the boundary of the lax phoneme.⁴ This suggests his 2009 short-a pattern does not reflect a return to his native system, if we assume that he grew up with a split system.

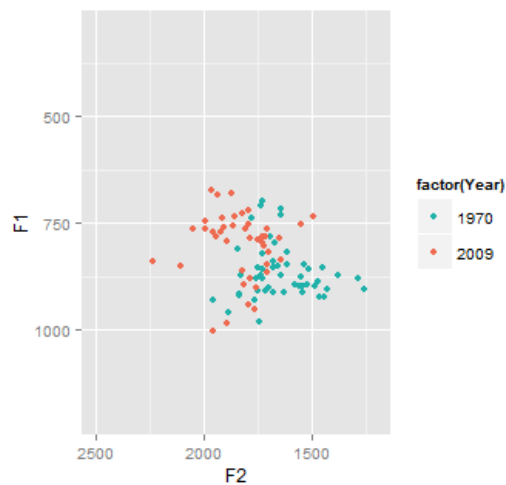


Figure 9: Short-a before voiceless fricatives and three lexical items *bad*, *mad*, *glad* in 1970 and 2009 (tense in the split system but lax in the nasal system).

⁴The effect of this fronting and raising, however, failed to reach statistical significance.

Lastly, Figure 10 shows tokens of short-a before stops that are lax in both the split and the nasal systems. As expected, there is no significant change between 1970 and 2009.

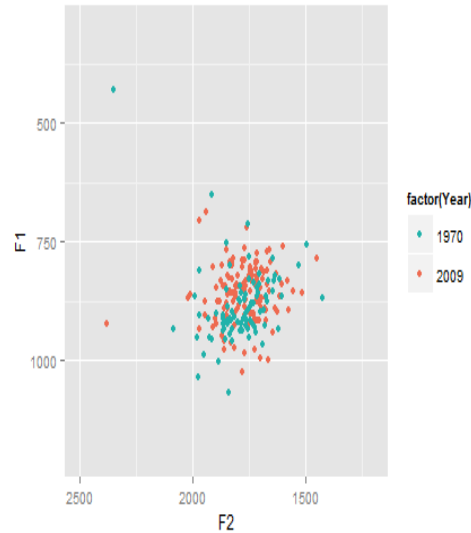


Figure 10: Short-a before stops in 1970 and 2009 (lax in both split and nasal system).

A closer look at the distribution of short-a depending on different environments reveals that Chomsky’s short-a pattern in 1970 does not correspond to either a split or a nasal system. What about the 2009 pattern? Two mixed models that differ from each other only in terms of two short-a systems⁵ reveal that, for F1, a nasal system explains the change in the data significantly better, whereas there was no significant difference for the change in F2.⁶ To summarize, Chomsky had neither a split nor a nasal system in 1970. Over a 40-year period, however, he came to have a short-a pattern similar to a nasal system, at least in terms of F1. I provide two possible scenarios regarding this.

The first scenario is that Chomsky grew up with a split system but has corrected it and superimposed a nasal system later on. Loss of one’s native system has been reported in a number of previous studies (Chambers 1988, 1992, Shockey 1984, *inter alia*). Chambers concludes that it is easier for second dialect learners to lose rules associated with the old dialect than to learn new rules associated with the new dialect. Likewise, it might not have been hard for Chomsky to abandon his native Philadelphia short-a system, especially when we consider how salient an extremely tensed [æh] variant is. It has been reported that people tend to associate tense /æh/ with a low social value and the general public perceive it as “harsh and nasal” South Philly slang. /æh/ produced the strongest negative responses on the scale of job suitability in Subjective Reaction Tests (Labov 2001). Also, Labov et al. 2013 recently finds that, in Philadelphia, there is an ongoing withdrawal from tensed /æh/ led by younger speakers with higher education. Considering such findings, it

⁵One model had a split system as a predictor and the other had a nasal system as a predictor, all others being equal, as follows:

- Split_system: $F1(F2) \sim \text{Year} * \text{Split} + \text{Stress} + (1|\text{word})$
- Nasal_system: $F1(F2) \sim \text{Year} * \text{Nasal} + \text{Stress} + (1|\text{word})$

	Short-a pattern	Df	AIC	BIC	logLik
F1	Split system	10	7318.7	7363.1	-3649.3
	Nasal system	10	7301.1	7345.5	-3640.6***
F2	Split system	10	7852.2	7896.6	-3916.1
	Nasal system	10	7877.9	7922.4	-3929.0

may not be very surprising for Chomsky, as a social figure, to avoid using the tense variant. Consequently, in 1970, Chomsky's production of short-a is invariably lax. After a 40-year period, however, Chomsky may have superimposed a nasal system. We might wonder, at this point, why he would start to tense before nasals if he wanted to avoid tensing. I want to draw your attention to the fact that all of his tense tokens in 2009 are at /ɛ/ level, not extremely tensed, which is not subject to stigmatization. Also, I want to point to the findings that coarticulatory nasalization may affect F1. Acoustically, movements of the velum that result in vowel nasalization alter vowel height: a significant F1 lowering (Chen 1997). That is, it is possible that Chomsky, when reconstructing the /æ/ of other speakers, may have misperceived the coarticulatory nasalization and falsely associated it with raising of F1, failing to undo the coarticulatory effect and derive the correct underlying phonological form (Ohala 1981).

The second scenario is that Chomsky grew up with no particular short-a pattern but came to learn a somewhat incomplete nasal pattern after he relocated to Boston. Guy (p.c.) reports his personal experience as a native speaker of Philadelphia that many Jewish speakers he encountered in Philadelphia did not display the split system which most Philadelphia natives have. Some ethnic groups often do not participate in patterns of the larger speech community, marking different ethnic identity from surrounding groups (Labov 1972, Poplack and Tagliamonte 1999, Rickford 1985). Although Chomsky did not have any short-a system, after he moved to Boston, he may have learned a nasal system as a second dialect learner.

7 Conclusion and Directions for Future Work

We have seen that Chomsky's accent has significantly changed over a 40-year period. His low back vowel /o/ has shifted significantly in close approximation with /oh/. Also, his short-a system appears to have gone through a phonemic restructuring.

The findings of this study suggest that an adult speaker is capable of making significant accent shift well past the critical period. Also, the shift of /o/ approaching /oh/ shows that Chomsky was able to adopt features of a new ambient dialect over time as a result of contact with a second dialect. These are consistent with previous findings showing that individuals may alter their use of phonological variables to reflect ongoing community changes or to adapt to the norm of the new speech community (Bowie 2000, Conn and Horesh 2002, Sankoff 2004, Sankoff and Blondeau 2007, Wagner 2008, Nycz 2011, Wagner and Sankoff 2011). However, such findings do not and cannot refute the fact that intraspeaker linguistic changes become less likely after the critical period (Lenneberg 1967). Rather, the findings here call attention to a certain extent of the malleability of an individual's language after the critical period, which should be considered when studying language change to obtain more accurate pictures of the nature of language change at the community level, as well as at the individual speaker level.

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