

PHONETIC AND PHONOLOGICAL CHANGES OF NOAM CHOMSKY: A CASE STUDY OF DIALECT SHIFT

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ABSTRACT: This study presents acoustic evidence of diachronic accent change of an adult speaker who relocated to a region characterized by dialect features different from those of his home region. Noam Chomsky was chosen as the subject because he exemplifies the effects of relocation on adult phonology. Chomsky was born and raised in Philadelphia, Pennsylvania, but at his age 27, he moved to Boston, Massachusetts. Three linguistic variables that have different systems in Philadelphia and Boston were examined in this study: (1) /a/-/ɔ/ distinction in Philadelphia and /a/-/ɔ/ merger in Boston, (2) the split short-*a* system in Philadelphia and the nasal system in Boston, and (3) strong fronting of /o/ in Philadelphia and moderate fronting in Boston. Acoustic analyses of Chomsky's public speech in 1970 and 2009 show that his /a/ has significantly shifted along both F1 and F2 over the 40 years, while /ɔ/ remained stable. Despite the substantial shift of /a/, this change has not led to a merger of two vowel categories. Meanwhile, his short-*a* pattern has gone through a striking phonemic reorganization over the 40-year period; Chomsky exhibited the unsplit pattern in 1970 but by 2009 he appears to have adopted a (somewhat incomplete) nasal system. With regard to /o/, he did not show any significant change, exhibiting only moderate fronting both in 1970 and 2009. This study demonstrates remarkable intraspeaker changes over a lifetime, although the changes did not reach categoricity. Possible social and phonetic factors that play an important role in these changes are discussed.

KEYWORDS: dialect shift, vowel changes, intraspeaker changes, stigmatized social markers, coarticulatory nasality

THIS STUDY PRESENTS acoustic evidence for longitudinal vowel shifts of a speaker who relocated as an adult to a region that is characterized by dialect features different from those of his home region. The question of the extent to which phonological changes can occur in the speech of an adult has received relatively little attention in the linguistic literature: stability of adult phonology has long been assumed to be the default case. A strong view of human cognitive development even posits that a speaker's phonology is hard wired or fixed in the brain by adolescence; changes after adolescence,

if any, take place at the lexical or discourse level only (e.g., Trudgill 1986).

In this connection, it has been established that the degree of acquisition of a second regional dialect is inversely correlated with a speaker's age and age of arrival. In a study of six Canadian-born preteens and teenagers who emigrated to Oxfordshire in southern England, for example, Chambers (1988, 1992) showed that two of the older subjects, the 14-year-old and the 17-year-old, had made no progress in acquiring the unmerging of low back vowels, whereas the two youngest subjects showed 80–90% unmerging. Thus, he concluded that younger speakers have advantages in acquiring second-dialect phonology and that older speakers tend to fail in learning complex phonological rules of a second dialect.

Payne (1976) also emphasized that speaker age and age of arrival are the most important predictors in acquiring second-dialect features. In a study of the acquisition of various phonological and phonetic variables by 34 children who had moved to King of Prussia, a suburban area of Philadelphia, she showed that the youngest group (age 0–4) had the highest proportion of Philadelphia glides, followed by their immediate elders, those who arrived between 4 and 9 years of age. The majority of children between 10 and 14 years of age did not acquire even the simple rules of a second dialect. She, therefore, concluded that, for full acquisition of second-dialect features, children need to be exposed to the phonetic and phonological rules by age 9 or 10. These early findings regarding children's second-dialect acquisition imply that acquiring phonological rules of a second dialect is extremely difficult, if not impossible, for adult speakers.

However, there is mounting evidence demonstrating adult speakers' capability of acquiring second-dialect phonology well beyond the critical period.¹ Shockey (1984), for example, shows four native speakers of American English who moved to Essex as adults reduced flapping to a significant extent. Conn and Horesh (2002) illustrate the successful acquisition of second-dialect vowel features by two adult natives of Michigan who moved to Philadelphia; one subject did not modify her production of (æ), but showed quantitative changes in the fronting of /o/, while the other speaker did not show any change in the /o/-fronting, but came to show some distinction between unraised and raised /æ/. Nycz (2011) finds that, out of 17 native Canadians who moved to the New York City region as adults, 11 speakers show evidence of having acquired a phonemic distinction between /a/ and /ɔ/.

While the previous research has made significant contribution to enhancing our understanding of the nature of second-dialect acquisition by adult speakers, due to the paucity of the studies, we still have limited knowledge regarding the following questions: Are speakers capable of modifying their

phonological systems in their adulthood? If so, is the modification limited to a subphonemic level, or can it occur at a higher level? If one succeeds in making a qualitative phonological change, how successful is the mastery of the acquisition of the rule? Given that making changes to a phonological system past the critical period is exceptional or hard to achieve, what is the driving force of the change? Do social factors come into play?

The present study addresses these questions by investigating the longitudinal vowel shifts in Noam Chomsky's speech between 1970 and 2009. Noam Chomsky was chosen as a speaker of the study since his speech is an excellent example of a long-term accent change as a result of relocation. He was born and raised in Philadelphia, Pennsylvania, but at age 27, he moved to Boston, Massachusetts. This study, therefore, contributes to a growing body of research documenting the extent of the changes a mobile adult exhibits by tracking possible vowel changes across the life span of a second-dialect learner.

THE SPEAKER

Chomsky was born in 1928 to Jewish parents in Philadelphia, Pennsylvania. His parents' first language was Yiddish, but Chomsky (2004) mentioned in an interview that his parents never spoke Yiddish at home and that he learned English as his first language.² Chomsky came from a relatively privileged socioeconomic class: his family lived in the affluent neighborhood of East Oak Lane in Philadelphia. Also, he grew up in an intellectually stimulating environment since both his parents worked in education: his father was a professor of Hebrew at Gratz College and his mother a teacher. Graduating from Central High School of Philadelphia, Chomsky began studying philosophy and linguistics at the University of Pennsylvania in 1945. He received his doctoral degree in linguistics and joined the faculty of the Massachusetts Institute of Technology (MIT) in 1955 at age 27.³ He worked at MIT from 1955 to 2017 and has served as laureate professor at the University of Arizona since 2017.

LINGUISTIC VARIABLES

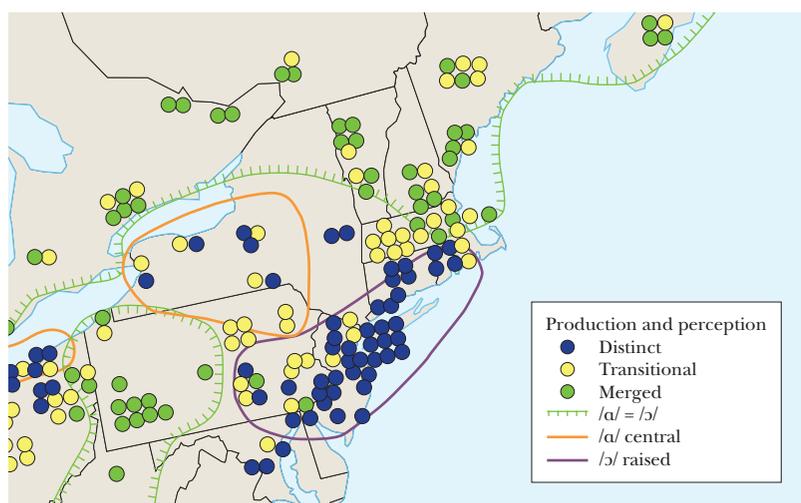
The three linguistic variables chosen for this study are three different vowel features: low back vowels, short-*a*, and a back-upgliding vowel /*o*/.

One major unconditioned merger in North America reported in the *Atlas of North American English* (Labov, Ash, and Boberg 2006) is the loss of contrast between the short-*o* class (/*ɑ*/) of *got*, *rock*, and *top* (LOT in Wells

1982) and long open-*o* (/ɔ/) in *law*, *talk*, and *caught* (THOUGHT in Wells 1982), which is often called the low-back merger or the *cot-caught* merger. Figure 1 illustrates the geographic distribution of the low-back merger. We see that throughout the Mid-Atlantic States, including Philadelphia, /ɑ/ and /ɔ/ are kept distinct: native speakers of Philadelphia distinguish /ɑ/ in *cot* from /ɔ/ in *caught*. In contrast, a high concentration of merged or transitional speakers can be seen in New England. Boston is a part of this region where the merger of /ɑ/ and /ɔ/ predominates. In this area, speakers' production of *cot* and *caught* are the same.

The second variable under investigation is short-*a* (TRAP in Wells 1982) pattern. Throughout the Mid-Atlantic States, including Philadelphia, short-*a* shows a phonemic distinction between raised, fronted, and occasionally diphthongized (tense) and low-front (lax) /æ/,⁴ which is called the split short-*a* system (Ferguson 1975; Labov 1989; Labov, Ash, and Boberg 2006, chap. 17). This distinction is subject to several phonological and lexical constraints: short-*a* is raised 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). Boston, as a part of Eastern New England region, is known to have the nasal short-*a* system.⁵ Unlike the split system, the nasal system is characterized by the wide separation between raised short-*a* before

FIGURE 1
Geographic Distribution of the Low-Back Merger
(based on Labov, Ash, and Boberg 2006, map 9.2)

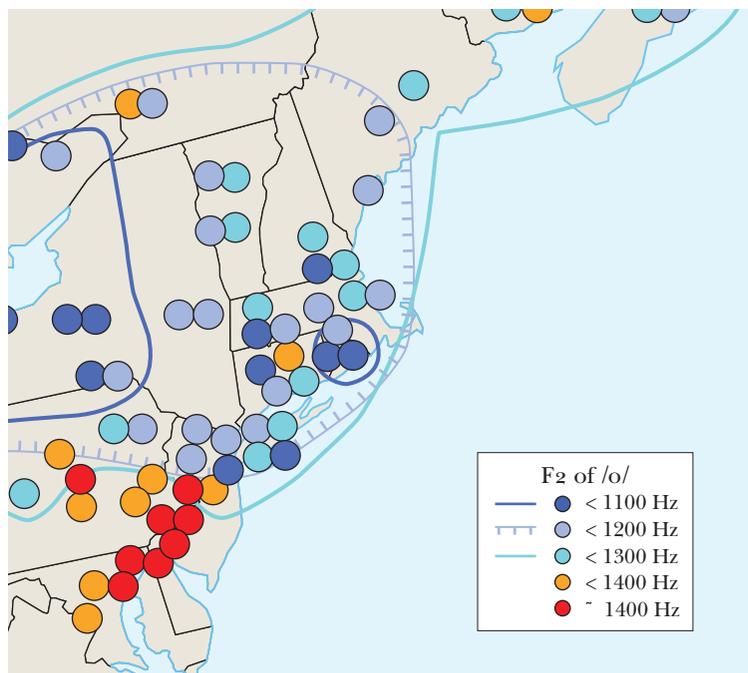


NOTE: The transitional speakers show pairs phonetically in close approximation.

nasal consonants and others elsewhere, regardless of syllabic or morphological status.⁶ The nasal system is the most widespread short-*a* system in North America and is regarded as a default American short-*a* pattern, occurring in disjointed and unrelated regions across the states (Labov, Ash, and Boberg 2006, 174–75).

The third variable is the realization of a back-upgliding vowel /o/ (GOAT in Wells 1982), as in *over* and *most*. Figure 2 illustrates the geographic distribution of the fronting of /o/ in North America (Labov, Ash, and Boberg 2006, map 12.3). The degrees of fronting are divided into five levels, from strong to minimal fronting, as seen in the legend. In Philadelphia, the nucleus of /o/ in both checked (/oC/), as in *goat* and *toast*, and free (/oF/) allophones, as in *go* and *sow*,⁷ is strongly fronted to the extent that F₂ of /o/ nuclei ranges above 1400 Hz, except before /l/.⁸ The position of the nucleus of /o/ in the Boston area is radically different from that of Philadelphia. In Eastern New England which includes the greater Boston area, /o/ is fronted only moderately, with F₂ of a nucleus less than 1200 Hz (Labov, Ash, and Boberg 2006, 156).

FIGURE 2
Geographic Distribution of the Fronting of /o/
(based on Labov, Ash, and Boberg 2006, map 12.3)



DATA

DATA SOURCE, FORCED ALIGNMENT AND VOWEL EXTRACTION, AND NORMALIZATION. Two recordings of Noam Chomsky's public speech were chosen as sources of data. The earlier recording is a talk titled "Government in the Future" that Chomsky delivered at the Poetry Center of the New York in 1970, at which point he was 42 years old and had been living in Boston for about 15 years.⁹ The later recording is a speech titled "Crisis and Hope: Theirs and Ours," which Chomsky delivered at the Riverside Church in Harlem in 2009, at which point he had lived in Boston for more than 50 years. Special care was taken to choose speeches that were comparable in style.

For the vowel analyses, the Forced Alignment and Vowel Extraction (FAVE) program suite (Labov and Rosenfelder 2011) was used.¹⁰ The two recordings were transcribed, and the orthographic transcript and audio recordings were entered into the FAVE-align program, which produces TextGrid files with each word and phoneme of the speech data aligned and timestamped to indicate their exact locations in the sound file. The FAVE-extract program then uses the sound file and the TextGrid file to measure the first and second formant of each vowel nucleus. A total of 10,178 of vowel tokens (4,152 in 1970; 6,026 in 2009) were extracted, and their frequencies of F1 and F2 were analyzed automatically. Of these, 964 tokens were used for the analysis of low back vowel system and 844 for that of the short-*a* system (see table 1).

The F1 and F2 frequencies in each recording were then normalized using Lobanov's (1971) normalization procedure to factor out any physiological

TABLE 1
Date Sources and the Number of Tokens

Year of recording	1970	2009
Data source	"Government in the Future"	"Crisis and Hope: Theirs and Ours"
Number of all vowels	4,152	6,026
Number of low back vowels	392 (/ɑ/, 245; /ɔ/, 147)	572 (/ɑ/, 341; /ɔ/, 231)
Number of short- <i>a</i> ^a	361	483
Number of /o/	219	263

- a. Three tokens of *Bangladesh* and four tokens of *Iraq* were excluded from the analysis of short-*a* because the first vowel in *Bangladesh* and the second vowel of *Iraq* were produced as /ɑ:/ not /æ/. Hall-Lew, Coppock, and Starr (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 /ɑ:/.

changes, possibly due to aging or vocal tract maturation, and retain only the linguistically meaningful changes. All vowel measurements are provided in normalized Hertz values throughout this article.

DATA ANALYSIS. *Adjusted Euclidean Distance.* The distance between /a/ and /ɔ/ was quantified using an adjusted Euclidean distance, following Nycz (2011) and Nycz and Hall-Lew (2013). Adjusted Euclidean distance is calculated from the effect size, or estimate, associated with VOWEL CATEGORY (/a/ or /ɔ/) in the mixed regression model with other fixed effects of linguistic constraints (PHONOLOGICAL ENVIRONMENTS and STRESS) and the random effect of WORD included. Given the unbalanced nature of the data in terms of phonological environment and number of tokens per word, adjusted Euclidean distance is particularly useful in that it lessens a word-specific effect (Nycz and Hall-Lew 2013).

Spectral Overlap Assessment Metric (SOAM). The degree of overlap between /a/ and /ɔ/ was quantified in two-dimensional (F₁, F₂) space through Spectral Overlap Assessment Metric (SOAM), a geometrical method for computing overlap between vowel distributions (Wassink 2006). In SOAM, normalized scatter for two vowel distributions is modeled as two best-fit ellipses in F₁ × F₂ space. The extent of overlap between two ellipses is calculated based on a fraction of uniformly distributed test points in the region of overlap relative to the number of test points in each vowel distribution. The degree of overlap is expressed as a percentage.

LOW BACK VOWELS /a/ AND /ɔ/

The longitudinal change in Chomsky's low back vowels is investigated in this section. Specifically, it will be shown whether Chomsky's low back vowels /a/ and /ɔ/ show evidence of a phonological merger or a phonetic approximation, reflecting an adjustment toward the New England system.

Figure 3 plots Chomsky's low back vowels in 1970 and 2009. There is a clear distinction between the vowels in 1970, which is largely maintained in 2009. Note, however, that his /a/ in 2009 is notably raised and more retracted compared to the vowel in 1970. Consequently, the two categories are closer to each other in 2009 than in 1970. Let us now see if quantitative analyses can confirm the impressionistic interpretations.

First, the measurements of the adjusted Euclidean distance confirm that the distance between the vowels have significantly diminished over the 40-year period. As can be seen in table 2, the adjusted Euclidean distance

FIGURE 3
Chomsky's Distribution of Low Back Vowels in 1970 and 2009

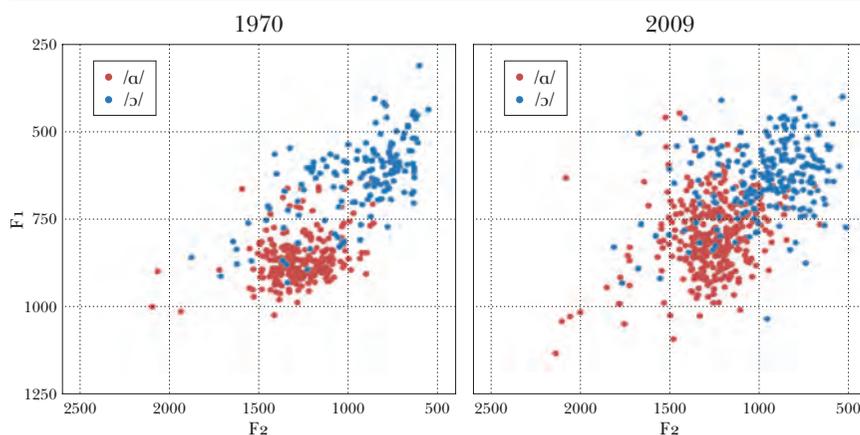


TABLE 2
Adjusted Euclidean Distances between /a/ and /ɔ/ in 1970 and 2009

Year	1970	2009
F1	183.92 Hz	136.43 Hz
F2	218.33 Hz	195.21 Hz
Adjusted Euclidean distance	285.27 Hz	237.74 Hz

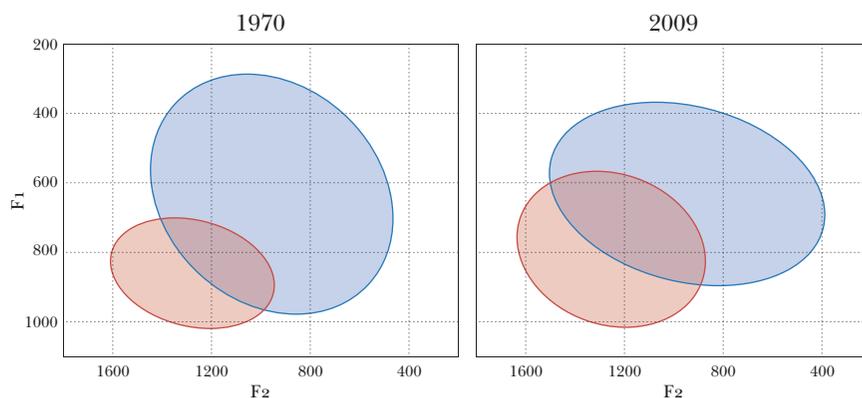
between the vowels has decreased 16.7% over the 40-year period (from 285 Hz in 1970 to 238 Hz in 2009). Consequently, the vowels in 2009 are less distinct than in 1970.

Next, the SOAM analyses confirm that the degree of overlap between the two vowels has increased over the 40 years, from 41.6% in 1970 to 48.5% in 2009 (see figure 4). This indicates that the degree of overlap increased by 16.7% between 1970 and 2009.

To determine whether there was a significant shift in Chomsky's low back vowels along either the F1 or F2 dimension between 1970 and 2009, linear mixed-effects model analyses were carried out separately on F1 and F2 of the two vowels. Using lmer() function from the lme4 package (Bates, Maechler, and Bolker 2012) in R (R Development Core Team 2012), a mixed effects model was fit to the F1 and F2 values of the two vowels in Chomsky's speech in 1970 and 2009.

For /a/, YEAR is a significant predictor for F1 (estimate = -60.278, SE = 8.459, $p < .0001$), which indicates that F1 of the vowel in 2009 is significantly

FIGURE 4
Two Dimensional Overlap of Comsky's Low Back Vowels, Generated by SOAM



lower than in 1970. For F_2 of /a/, YEAR was marginally significant (estimate = -147.22 , $SE = 75.72$, $p = .0525$). In sum, /a/ approximated toward /ɔ/, especially along the F_1 dimension, over the 40 years.

The results from the linear mixed models on F_1 and F_2 of /ɔ/, in contrast, show that YEAR failed to reach significance, indicating that /ɔ/ did not exhibit a significant shift between 1970 and 2009.

To ascertain whether the shift of /a/ between 1970 and 2009 led to the merger of two phonemes, it was examined whether the two vowels in 2009 still exhibit a significant difference. The linear mixed model on F_1 and F_2 of /a/ and /ɔ/ in 2009 selected VOWEL CATEGORY as a significant predictor in explaining the distribution of the two vowels in both F_1 and F_2 dimension ($p < .001$ for F_1 ; $p < .001$ for F_2), which reveals that they still remain two distinct underlying phonemes even after /a/ has come to approximate /ɔ/ over 40 years.

In sum, the adjusted Euclidean distance shows that the distance between the two low back vowels is greatly diminished between 1970 and 2009. The SOAM analyses also demonstrate that the area of overlap has greatly increased. The regression analyses confirm these findings, showing that Chomsky's /a/ has shifted significantly toward /ɔ/, particularly in the F_1 dimension, while his /ɔ/ remained largely stable. It was also shown that this change is a fine-grained phonetic shift not involving phonological restructuring in that there is no sign of a merger between two categories.

SHORT-A

Let us now turn to the changes in Chomsky's short-*a* system (i.e., the vowel /æ/), between 1970 and 2009. As discussed above, in the traditional split short-*a* system of Philadelphia, /æ/ is raised and fronted in syllables closed by coronal nasals (/n/, /m/), voiceless fricatives (/s/, /θ/, /f/), and in three words before /d/ (*mad*, *bad*, *glad*) (Labov 1989). Figure 5 displays the typical short-*a* vowel configuration of Philadelphians. Perlman and Berman, chosen from the Philadelphia Neighborhood Corpus (PNC) as comparable speakers to Noam Chomsky, are Jewish male speakers and were in their 40s when they were interviewed in 1974.¹¹ Their short-*a* systems show distinctly separate clusters for the raised and fronted /æ/ and the unraised /æ/.

In figure 6, Chomsky's short-*a* tokens in 1970 and 2009 are plotted based on the phonological and lexical conditioning of the traditional Philadelphia split system. His distribution of short-*a* is surprising if we expect him to have grown up with the split system. His short-*a* pattern in 1970 does not show any split. Almost all tokens are within the cluster of unraised /æ/. His short-*a* pattern in 2009 is more striking in that he displays many raised tokens that he did not show 40 years earlier. Compared to the configuration of the split system of two Philadelphians in figure 5, however, the boundary between raised /æ/ and unraised /æ/ is not quite distinct.

Chomsky may instead display is the nasal short-*a* system, given that it is a more generalized North American pattern and prevails in New England.

FIGURE 5
Philadelphia Split Short-*a* System of Two Philadelphia Natives Interviewed in 1974

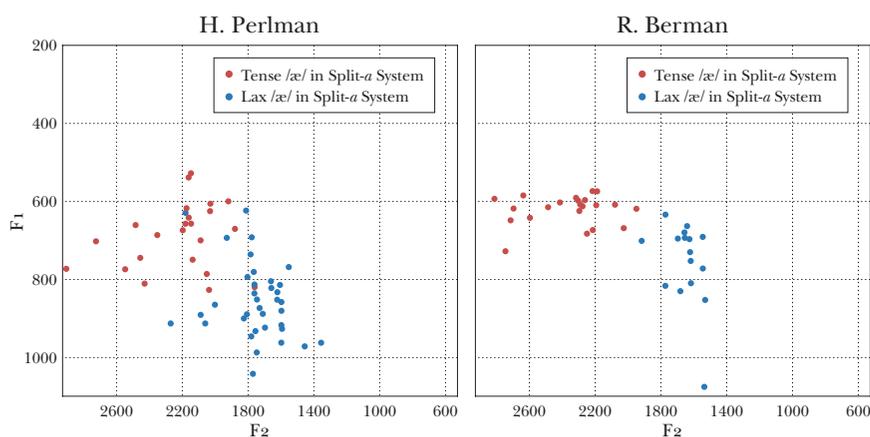
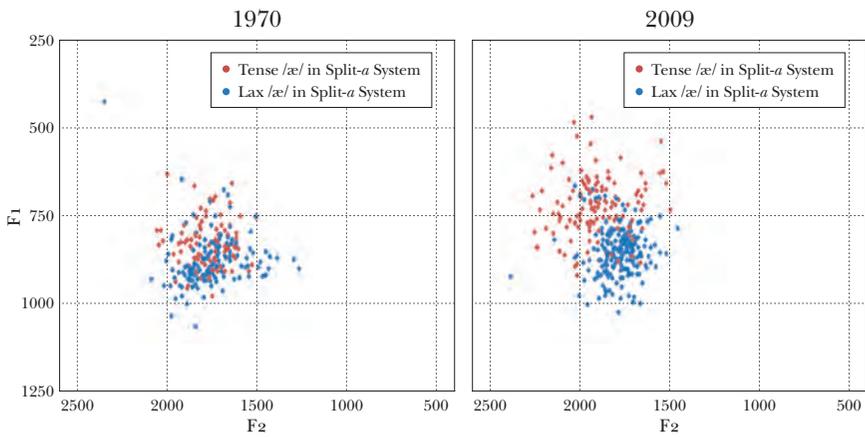
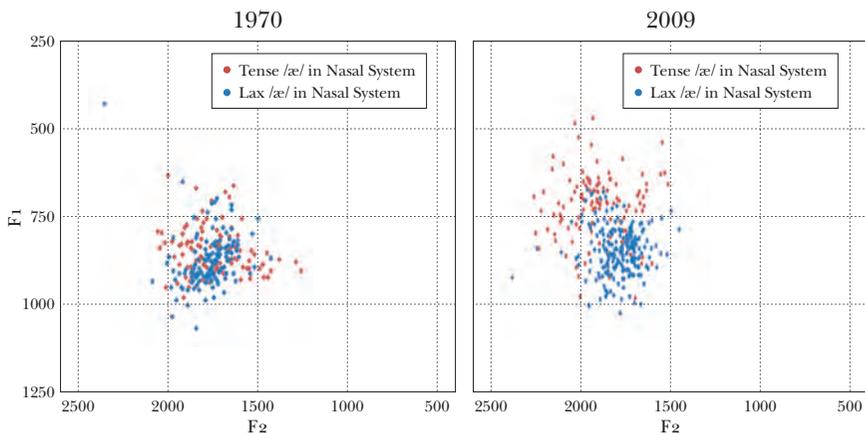


FIGURE 6
Chomsky's Short-*a* Distribution in 1970 and 2009 Based
on the Philadelphia Split System



In the nasal system, short-*a* is raised before nasals, and all others remain low front. Figure 7 plots Chomsky's short-*a* pattern based on the nasal system. However, his short-*a* pattern in 1970 does not correspond to the nasal system either, because short-*a* tokens followed by a nasal are within the boundary of unraised /æ/. Meanwhile, the 2009 pattern is reminiscent of that of the nasal system: although there is a moderate degree of overlap, we can see a tendency for prenasal short-*a* to be in an upper mid position in the pho-

FIGURE 7
Chomsky's Short-*a* Distribution in 1970 and 2009 Based on the Nasal System



netic space while nonprenasal ones occupy a low position. Strictly speaking, however, it is not quite the nasal pattern that has a clear boundary between raised and unraised allophones.

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

Figure 8 shows the distribution of short-*a* before tautosyllabic anterior nasals (raised in both systems) in 1970 and 2009. Short-*a* in this environment is noticeably more raised and fronted in 2009 than it was in 1970.

Figure 9 shows tokens of short-*a* before velar nasal /ŋ/ and nasals in open syllables that are unraised in the split system but raised in the nasal system. In these environments, there is no significant change between 1970 and 2009. This suggests that Chomsky has not fully accommodated to the local the nasal system.

Then what happened to Chomsky's short-*a* before voiceless fricatives and in three lexical items *bad*, *mad*, and *glad* that are raised in the split system but unraised in the nasal system? In figure 10, we see that, over the 40 years, some tokens in this environment fronted and raised a little. While the effect of fronting was statistically significant ($t(66) = -4.8, p < .01$), the effect of raising failed to reach statistical significance ($t(52) = 1.29, p = .204$). So,

FIGURE 8
Short-*a* before Tautosyllabic Anterior Nasals in 1970 and 2009
(raised in both the split and nasal system)

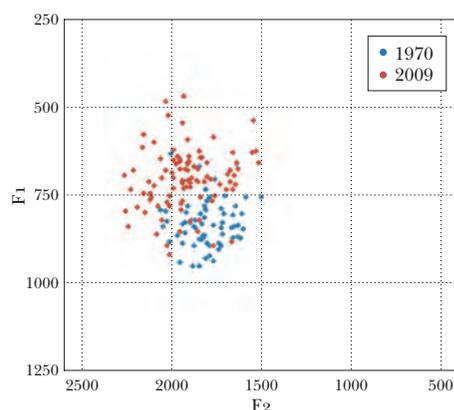


FIGURE 9
Short-*a* before Velar Nasals and Nasals in Open Syllable in 1970 and 2009
(unraised in the split system but raised in the nasal system)

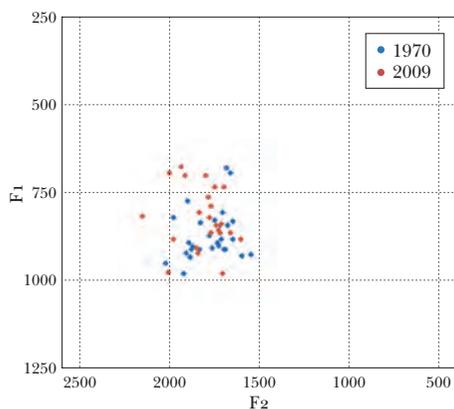
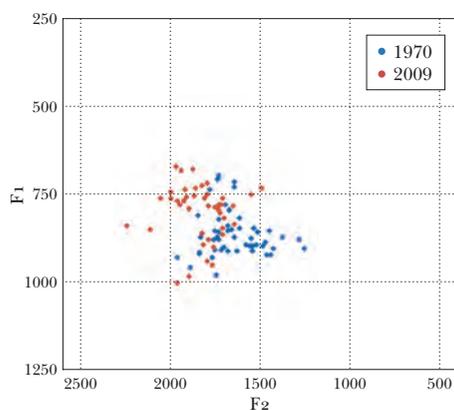


FIGURE 10
Short-*a* before Voiceless Fricatives and Three Lexical Items *bad*, *mad*, and *glad*
in 1970 and 2009 (raised in the split system but unraised in the nasal system)

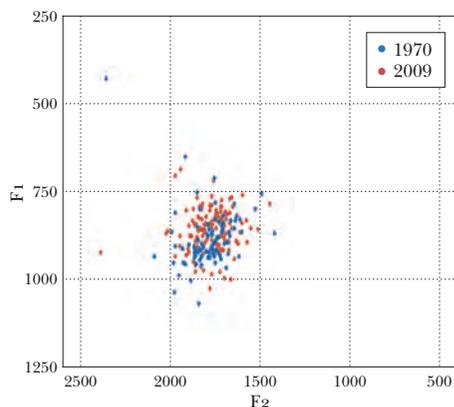


again strictly speaking, it is unlikely the 2009 pattern reflects a re-emergence of the split system, if we assume Chomsky grew up with it.

Lastly, figure 11 displays short-*a* tokens before stops that are unraised in both systems. As expected, there was no significant change between 1970 and 2009.

Since a closer look at the distribution of short-*a* in different environments does not provide much clue regarding which short-*a* system Chomsky

FIGURE 11
Short-*a* before Stops in 1970 and 2009
(unraised in both the split and nasal system)



had in 2009, statistical measures were employed as a last resort. Two linear mixed-effects regression models, one with the split system as one of the predictors and the other with the nasal system, were compared in terms of their log likelihoods as well as Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), the two most commonly used penalized model selection criteria, as shown in table 3.¹² The likelihood ratio test reveals that the nasal system explains the F1 distribution in 2009 significantly better than the split system. Smaller AIC and BIC values support this. In contrast, there was no significant difference between the two models for the distribution of F2 in 2009.¹³ Therefore, it is still not clear whether his 2009 short-*a* pattern reflects the split system or the nasal system.

One point that merits some discussion here regards how Chomsky’s short-*a* system has changed in his lifetime. There are three plausible scenarios. One possibility is that Chomsky grew up with the split system but corrected his short-*a* extensively before leaving Philadelphia. As he ages, however, he

TABLE 3
Comparison of the Split System Model and Nasal System Model

	<i>Model</i>	<i>df</i>	<i>AIC</i>	<i>BIC</i>	<i>logLik</i>
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

is returning to his native dialect. There is a good reason to suggest that he had stayed away from the Philadelphia split system even before he left the city. In Philadelphia, raised /æ/ is often associated with a low social value and evaluated negatively (Labov, Rosenfelder, and Fruehwald 2013; Labov et al. 2016; Prichard 2016). Raised /æ/ along with the extremely raised and diphthongized variant of [i:ə] bear strong negative social evaluation and the general public perceives it as a “harsh and nasal” South Philly slang (Labov, Rosenfelder, and Fruehwald 2013). In subjective reaction tests, raised /æ/ received the lowest rating on the scale of job suitability (Labov 2001). A recent project on the Impact of Higher Education on the Local Phonology (IHELP) revealed that young Philadelphians oriented to higher education are transitioning from the traditional Philadelphia system to the nasal system (Labov et al. 2016). Prichard (2016) provided the candid description given by six Philadelphians in their 20s from the IHELP data set about the most stereotypical local features of Philadelphia and their feelings about them. It is worth noting that, among the six speakers, the three speakers who attend a national university and display clearly negative attitudes toward the Philadelphia dialect have the nasal system; the two speakers who attend a regional university and do not explicitly show the negative attitude toward the local accent have retained the Philadelphia split system.¹⁴ Given the discussion above, it is conceivable Chomsky corrected his short-*a* realization with a similar motivation of the younger Philadelphians oriented to higher education. Once Chomsky shifted away from the system he grew up with, why then would a split system reappear when Chomsky was older? It is widely established that older people tend to increase the use of the vernacular forms while their use of the standard forms decreases once they are no longer in the workforce (Labov 1981). Although Chomsky is still an active scholar and public intellectual, with age he might have become more relaxed with his language and this may have led him to return to the system he had in his childhood.

Another scenario is that Chomsky grew up with the split system but shifted toward the nasal system after moving to Boston. Loss of one’s native system in second dialect acquisition has been reported in a number of studies (e.g., Shockey 1984; Chambers 1988, 1992; Sankoff 2004). Chambers (1992) argues that it is easier for second-dialect learners to lose rules of an old dialect than to learn rules of a new dialect. Likewise, it is possible Chomsky abandoned his native Philadelphia short-*a* system especially considering the negative evaluation of raised /æh/ discussed above and adapted to the norm of the new ambient dialect.

A third possible scenario is that Chomsky grew up with no particular short-*a* pattern but came to learn the nasal system after being exposed to

the ambient dialect in Boston. Gregory Guy (pers. comm., Oct. 19, 2013) reports his personal experience as a native speaker of Philadelphia, noting that many of the Jewish speakers he encountered in Philadelphia did not display the split system of most Philadelphia natives. Some ethnic groups often do not participate in the linguistic pattern of a larger speech community, marking a different ethnic identity from surrounding groups (Labov 1972; Rickford 1985; Poplack and Tagliamonte 1999). Also, the fact that Chomsky's parents were not originally from Philadelphia may have affected the acquisition of his short-*a* pattern. Payne (1976) found that a majority of the children born locally to migrant parents failed to acquire the Philadelphia short-*a* pattern completely. She therefore concludes that if a child's parents are not born and raised locally, the chance of that child acquiring the short-*a* pattern perfectly is very low. Although Chomsky had the unsplit pattern in the beginning, he may have learned the nasal system somewhat incompletely as a second dialect learner after he relocated to Boston.

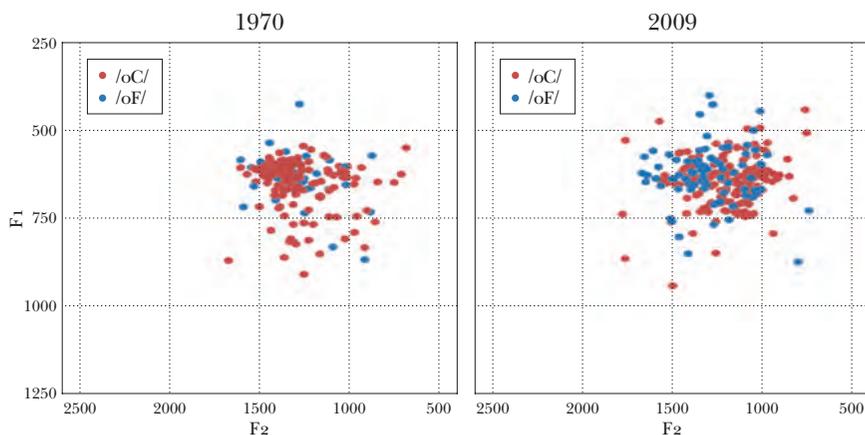
It is still inconclusive whether his short-*a* pattern in 2009 reflects the pattern of the traditional Philadelphia split system or the nasal system, and it is unknown which system he grew up with. Our analysis of the next vowel feature, /*o*/, may offer a clue into this puzzle.

MID BACK VOWEL /*o*/

In this section, I examine whether Chomsky exhibits the fronting of the back upgliding vowel /*o*/, as most Philadelphians do, and whether he shows some changes in /*o*/ between 1970 and 2009. As discussed above, in Philadelphia, the nucleus of /*o*/ in both checked and free allophones is fronted significantly to the extent that F₂ of the /*o*/ nuclei is greater than 1400 Hz, except before /*l*/. Although the fronting of /*o*/ prevails in Philadelphia, it is not as salient or stigmatized as raised /*æ*/ and /*ɔ*/ are (Labov, Rosenfelder, and Fruehwald 2013).¹⁵ Therefore, it is reasonable to expect that a speaker from Philadelphia would be less likely to change this vowel feature when relocating to another region. I first examine whether Chomsky exhibits fronting at all either in 1970 or 2009 and then whether he has made any changes in his realization of the vowel over a 40-year period.

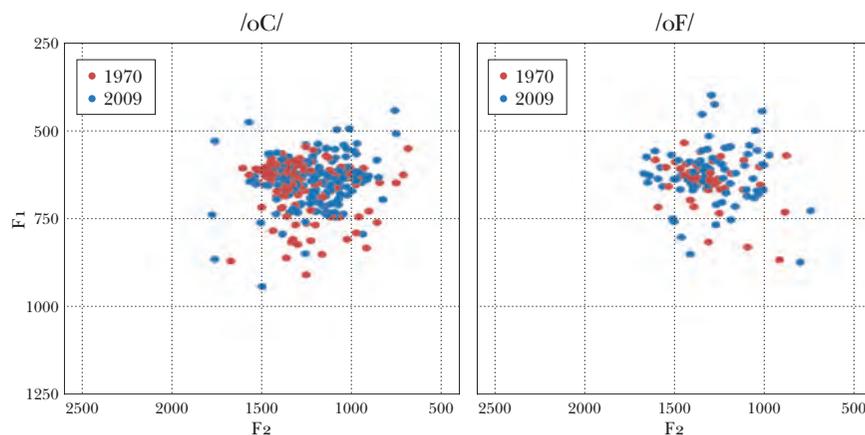
Figure 12 displays all tokens of Chomsky's /*o*/ in 1970 and 2009. The realization of Chomsky's /*o*/ nucleus stands in stark contrast to the highly fronted /*o*/ nuclei of Labov, Ash, and Boberg's (2006) Philadelphia speakers, the F₂ of which were above 1400 Hz. The nucleus of Chomsky's /*o*/ is fronted only slightly, with its mean F₂ as low as 1282 Hz in 1970 and 1228 Hz in 2009.

FIGURE 12
Chomsky's /o/ Tokens in 1970 and 2009



Chomsky's tokens of /o/ in 1970 and 2009 are plotted in figure 13 to examine possible changes in his /o/ realization. Neither checked nor free tokens appears to show a noticeable change over the 40 years. This is confirmed by linear mixed-effects analyses, which show that YEAR failed to reach statistical significance for both free and checked /o/ when the model was fit to the F2 value in 1970 and 2009. This indicates that no meaningful difference was made to the nucleus of /o/ along the F2 dimension over a 40-year period.

FIGURE 13
Chomsky's Checked and Free Tokens of /o/ in 1970 and 2009



What we can conclude from the analysis of /o/ is that Chomsky does not exhibit fronting of /o/ to the same degree as other Philadelphians and that he remained stable over the 40 years in terms of this vowel feature. Moreover, the moderate fronting he displays both years is reminiscent of the degree of fronting found in the New England region ($F_2(o) < 1200$ Hz). This strongly implies that Chomsky's general pattern has lacked the local vowel features of the Philadelphia dialect, hence it is very likely he did not participate in the pattern of Philadelphia split short-*a* system from the beginning. For this reason, I suggest that his short-*a* configuration in 2009 would be better explained by his shift toward the system of Boston rather than a return to the system of his hometown.

GENERAL DISCUSSION

Thus far, I have demonstrated that Chomsky made the significant changes in his low back vowels and short-*a* between 1970 and 2009, while his /o/ remained stable over the 40 years. His low back vowel /a/ has shifted significantly in close approximation with /ɔ/, although these two phonemes did not merge. Chomsky exhibited the unsplit short-*a* pattern in 1970, but his short-*a* system has undergone a striking phonemic reorganization over a 40-year period. Although his /o/ remained stable, /o/ is only moderately fronted, as it is in the New England area including Boston both in 1970 and 2009. Therefore, we can say that his vowel features became more aligned with the dialect of Boston rather than with that of his hometown, Philadelphia.

The significant quantitative changes in his low back vowels clearly indicate that an adult speaker is capable of making substantial quantitative changes toward the target dialect features. The fact that Chomsky restructured his short-*a* system is more striking because learning new phonemic features later in life has been considered extremely rare. The reorganization of Chomsky's short-*a* system clearly points to the capability of an adult speaker's making not only quantitative changes, but also qualitative changes, to his or her phonological system. This augments past research demonstrating the acquisition of new phonemic features of a second dialect later in life (e.g., Conn and Horesh 2002; Nycz 2011). Note, however, that Chomsky was not able to master either low-back merger or the nasal short-*a* system. In the second-dialect acquisition literature, it is reported that even young children exhibit incomplete acquisition and varying degree of mastery of second-dialect features (e.g., Payne 1976; Chambers 1988, 1992; Tagliamonte and Molfenter 2007). Therefore, it would be safe to conclude that adult speakers are capable of making significant qualitative and quantitative changes

to their phonological systems, but they certainly have sizeable obstacles in mastering second-dialect features.

Given that making significant alternations to one's phonological system as an adult is exceptional and one rarely reaches categoricity in acquiring second-dialect phonology (e.g., Sankoff and Blondeau 2007),¹⁶ what promotes such a challenging task then? One factor that may play an important role in speakers' shift to a new language or dialect is relative prestige of the target language or dialect. Bortoni (1991) and Surek-Clark (1998), in studying the development of a local dialect in Brazil, found that speakers of higher-prestige dialect acquired less of the target dialect, while speakers of lower-prestige dialects acquired more. Beniak and Mougeon (1989) also argued that the shift from Ontario French to English was partly facilitated by the lack of prestige of Ontario French.

It is possible that the relatively low prestige of the Philadelphia dialect caused by its association with "Southernness" may have motivated Chomsky's language changes. Labov, Rosenfelder, and Fruehwald (2013) show that young Philadelphians with higher education are leading a reversal of raised /æ/ and /ɔ/ and fronted /aʊ/, /o/, and /u/ after noncoronals, all features shared with the South Midland and Southern dialects and subject to negative social evaluation. Studies of perceptual dialectology have shown that the South is the most salient and stigmatized regional speech area in the United States and that Southern speech features are strongly associated with negative traits, such as "uneducatedness," "bad English," "abnormal," and "dumb" (Preston 1996, 1999, 2010). Raised /æ/ and /ɔ/ are strongly stigmatized social markers in Philadelphia,¹⁷ and even though fronted /o/ is less stigmatized, it is generally regarded as "not suitable for public formal speech" (Labov 2001, 211).¹⁸ It is considered the most prominent difference between the North and the South. Labov, Rosenfelder, and Fruehwald (2013) argue that the Philadelphians' movement away from the local phonology is driven by these features' association with the South. Given this, it is conceivable that the Philadelphia dialect's association with Southern speech could have led Chomsky to retreat from the Philadelphia dialect features in favor of Northern features after he relocated to Boston or, perhaps, even before he left the city. It is also possible that Chomsky had participated in this reorganization of the entire Philadelphia vowel system toward becoming more like the Northern dialects.

His retreat from Southern features in favor of the more prestigious norms of the North could have been reinforced by the fact that not only was he an academic who frequently interacted with people with higher education, but he also became a famous public figure in both linguistics and politics. An analogous case can be found in Shockey (1984), which showed that four

native American speakers who moved to England significantly reduced their flapping. All of her informants were on the teaching staff at the University of Essex and were originally speakers of Midwestern or Californian American dialects. Perhaps the British phonology had considerable cachet for them, and they may have been strongly motivated to change their phonological system to accommodate to the local dialect with its relatively higher prestige. Another parallel case would be the dialect shift of Sarah Gorby, a Yiddish folksinger, demonstrated in Prince (1987). Gorby was found to have made a substantial shift toward the standard variants in her vowel realizations, although she did not exhibit any qualitative attrition of her native dialect, which was generally stigmatized. She may have also been motivated to conform to a more prestigious norm as a public figure.

One unresolved question regards why Chomsky adopted the nasal system or began to raise short-*a* before nasals if he wanted to avoid producing the salient raised target altogether. It may be related to the fact that raised /æ/ before nasals may not sound as marked or stigmatized as raised /æ/ before oral consonants due to the effects of coarticulatory nasality. Coarticulatory effects of nasalization have the primary impact on the vicinity of the F₁ (Ohala 1974; Wright 1975; Beddor 1982; Chen 1997). Acoustically, movements of the velum that result in vowel nasalization alter vowel height, resulting in a significant F₁ lowering in the vowel spectrum. Also, the perception of vowel height can be influenced by nasalization. The low nasal vowels are perceptually raised and the high nasal vowels perceptually lower (Wright 1975; 1986). When two adjacent peaks in a vowel spectrum are close in frequency, listeners determine vowel quality based on some weighted average of the two peaks, or center of gravity, and they have difficulty in determining the contribution of oral tract configuration and velopharyngeal coupling to the spectral shape of a nasal vowel. An extra nasal peak in the region associated with vowel height results in a shift in the perceived height of nasal vowels (Goodin-Mayeda 2011).

Relating these findings to short-*a* pattern, Chomsky may have misassociated the coarticulatory nasalization with raising of F₁ when reconstructing the /æ/ of the nasal system (Ohala 1981, 1993). Due to this parsing error, Chomsky may raise F₁ of /æ/ in the prenasal context, failing to undo the coarticulatory effect of nasalization. Through this hypercorrective process, /æ/-tensing before a nasal may have been actuated at the level of the individual speaker. To see if this scenario is plausible, the change in the coarticulatory nasality of Chomsky's short-*a* before a nasal was examined. For a nasality measurement, the words with /æ/ before tautosyllabic anterior nasals in 1970 and 2009 were segmented via the script in Praat and the nasality of each vowel was measured in the difference in the amplitude of the F₁ harmonic

peak (A1) and the lowest nasal peak (Po): A1–Po. As nasality increases, A1 decreases and Po increases: the smaller A1–Po is, the more nasal the vowel is.¹⁹ Preliminary results show that A1–Po in 2009 is significantly lower (A1–Po in 1970 = -0.87 ; A1–Po in 2009 = -4.89 ; $t(49) = 5.0127$, $p < .001$), which indicates that Chomsky is significantly more nasal in 2009 than in 1970. Taken together, it is possible Chomsky might have learned to produce more raised /æ/ from the misanalyses of the coarticulatory nasalization effects, perceiving them as an unmarked way to produce /æ/ before a nasal.²⁰ It is also likely that he was not even aware that he had raised /æ/ before a nasal.

CONCLUSION

This article investigated the longitudinal vowel shifts in the speech of a speaker who relocated as an adult to a region characterized by different dialect features and explored the possible driving force behind the vowel changes of an individual speaker. Evidence was found that the speaker made a significant quantitative shift toward the new dialect feature in the low back vowel system and a more dramatic qualitative change in the short-*a* system. I suggest that these remarkable vowel changes could have been driven by social and phonetic factors: relative prestige and coarticulatory nasalization effects.

It remains necessary to compare and contrast other variables in Chomsky's speech to understand more fully the mechanisms that underlie the language changes of this second-dialect learner. Work on other vowel features aligned with the North, in particular, will broaden the evidence of the influence of relative prestige of Northern and Southern speech on Chomsky's vowel change across his life span. Further quantitative analyses of comparable speakers who were born and raised in Philadelphia but moved to the New England region will enable us to test the influence of other external factors on second-dialect acquisition, such as speaker age, gender, social class, and so on. An additional investigation into how the relative prestige of the target dialect affect the extent of the acquisition will increase our understanding of how social factors come into play in second-dialect acquisition. Lastly, more investigations of the role of coarticulatory nasality on the raising of short-*a* may shed light on the actuation of short-*a* raising at an individual speaker level.

NOTES

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1. In a similar vein, studies of life span changes in speakers who remain in one speech community throughout their lives reveal that adult speakers are able to make significant changes in the use of phonological variables, reflecting the sound changes taking place in the speech community. One well-known speaker, Queen Elizabeth II, has demonstrated such a diachronic accent change in the direction of ongoing community change. Harrington and his colleagues showed that the Queen’s vowel system has undergone a significant phonetic shift over a 50-year period, displaying the significant changes in her monophthongs as well as the overall vowel shape (Harrington, Palethorpe, and Watson 2000; Harrington 2006, 2007). Sankoff and Blondeau (2007) also provide compelling evidence for significant intraspeaker changes in adult speakers’ phonological systems, showing that 9 out of 32 speakers of Montreal French show a significant shift in the direction of using more of an innovative variant, a dorsal [R], than the old variant, an apical [r], between 1971 and 1984. Meanwhile, Yaeger-Dror (1994), Sankoff and Wagner (2006), and Wagner and Sankoff (2011) provide evidence of retrograde change, providing evidence of older speakers who become more conservative as they get older.
2. In his interview with Amy Goodman in 2004, Chomsky said that his parents spoke English at home and that speaking Yiddish at home was considered “taboo.”
3. Chomsky conducted part of his doctoral research at Harvard University as a Harvard Junior Fellow from 1951 to 1955. Thus, he began living in Boston a few years before 1955.
4. In describing short-*a* patterns, the tense-lax distinction is widely used to refer to the raised and fronted short-*a* class and low-front class, respectively. The tense-lax distinction is, however, not without a controversy (see, e.g., Halle and Stevens 1969; Catford 1977). Many phonologists have found this distinction very useful, especially for English, but phoneticians have been unable to identify articulatory and acoustic traits corresponding to this distinction. Therefore, instead of tense-lax, the tense class of short-*a* will be uniformly referred to as “raised” and the lax class “unraised.”
5. There are two other short-*a* systems reported in the literature to be attested in the Boston area: the broad-*a* system and the Northern breaking system. They were considered at the initial stage of the analysis but were not taken into consideration in the final analysis for the following reasons. In the broad-*a* system (Labov, Ash, and Boberg 2006, 174–75), a remnant of the British broad-*a* system, several common words of the British class are pronounced with a low-back vowel

[a], resulting in *laugh* [laf] or *aunt* [ant]. This system was excluded from the analysis because less than 2% of Chomsky's short-*a* tokens were produced with broad-*a*, which made it unlikely that Chomsky had the broad-*a* system. In the "Northern breaking" system (Wood 2011), short-*a* before voiceless fricatives and voiced stops has lower F2 values than in the nasal system and makes the transition to a second steady state, lowering its F2 even further. The resulting sound is like a diphthong or off-glide, which can be transcribed as [eə]. This system was also set aside because all of his tokens before voiced stops were realized as low front [æ].

6. In Eastern New England, the cluster of short-*a* before nasals in high front position is separated from that of low front short-*a* before nonnasals by as much as 600 Hz (Labov, Ash, and Boberg 2016).
7. /o/ in free position (/oF/) is usually positioned further front than when it is in checked allophone (/oC/) (Labov, Ash, and Boberg 2006).
8. Before /l/, /o/ is kept distinct at the back of the vowel space (Labov, Ash, and Boberg 2006, 155).
9. I wished to analyze his speech at around the time he moved to Boston, but the recording in 1970 was the earliest recording I was able to locate. Although the earlier recording does not reflect the vowel system Chomsky grew up with or what he had retained while living in Philadelphia, it is worth examining whether Chomsky changed his vowels well after he moved to Boston and, if so, document the changes he made later in his life.
10. A more detailed explanation of the FAVE procedures can be found in Labov, Rosenfelder, and Fruehwald (2013).
11. Noam Chomsky was 42 years old at the time of his 1970 talk.
12. The formulas were as follow:

The split system model:

$$F1 \sim \text{as.factor}(\text{Year}) * \text{Split} + \text{FolSeg} + \text{as.factor}(\text{stress}) + (1|\text{word})$$

The nasal system model:

$$F1 \sim \text{as.factor}(\text{Year}) * \text{Nasal} + \text{FolSeg} + \text{as.factor}(\text{stress}) + (1|\text{word}).$$

A model with a lower AIC or BIC value is considered to have a better fit to the data.

13. This finding, however, does not indicate there was no significant change in F2. YEAR was a significant predictor in both F1 and F2 dimensions, indicating there were a significant decrease in F1 of short-*a* (estimate = -35.55, SE = 10.07, $p < .001$) and a significant increase in F2 or fronting of short-*a* (estimate = 51.39, SE = 16.29, $p < .001$) between 1970 and 2009.
14. The remaining speaker in Prichard's (2016) study, who attends a national university and shows no strong attitudes toward the local accent, exhibits a completely overlapping distribution which is neither the Philadelphia split system nor the nasal system.
15. While raised /æ/ and /ɔ/ are considered the social stereotypes, /o/-fronting is categorized as the sociolinguistic marker (Labov 1966; Labov, Rosenfelder, and Fruehwald 2013).

16. Sankoff and Blondeau (2007), however, discuss the conditions of how speakers can reach categoricity in making changes to their phonological system in adulthood. If a speaker during their childhood learns a feature with no variation, major changes are unlikely to take place in the feature. However, if a speaker learns a feature as a variable one from their childhood, the speaker may change the balance of the variants during the speaker's lifetime.
17. Raised /ɔ/ bears supralocal negative social evaluation. People overtly comment on the way people in New York City pronounce words like *caught*, *coffee*, and *not*, and it is considered a negatively evaluated stereotype of New York City speech (Becker 2010, 2011). In Philadelphia, the social stereotype with regard to this vowel is confined to one word, *water*, where it is pronounced with a high back nucleus (Labov, Rosenfelder, and Fruehwald 2013).
18. In fact, the social evaluation of fronted /o/ does not appear coherently negative. In the subjective reaction tests conducted in the 1970s, out of four speakers, three speakers who produced the fronted nuclei of /o/ were downgraded but the fourth speaker was not rated negatively (Labov 2001).
19. The measurement was done by using the automated nasality measurement script in Praat at the midpoint of each vowel. I thank Will Styler and Colorado University Phonetics Lab for generously sharing the automated nasality measurement script.
20. This could be the mechanism that underlies the acquisition of the nasal system in one's childhood. More studies of the role of coarticulatory nasality on raising short-*a* are needed to evaluate this hypothesis.

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