

3-21-2010

Correlation of the Low-Back Vowel Merger and TRAP-Retraction

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1 Introduction

The combination of the low-back vowel merger, where distinction is lost between the vowels in THOUGHT and LOT, and the retraction of TRAP, where /æ/ shifts to something more [a]-like, can be found in many North American English dialects. In Canadian English, for example, these features are key to the “Canadian Shift” (Clarke, Elms, and Youssef 1995), though this combination is also reported in Northern Californian English (Eckert 2004). Gordon, relying on the “margin of security” theory as a motivation for vowel shift, has suggested that TRAP-retraction might be expected to eventually be found anywhere the low-back vowel merger exists (Gordon 2005). The suggestion is that as LOT and THOUGHT merge to a single value somewhere further back and higher than [a], the “available space” in which TRAP can vary is proportionally extended towards the back of the vowel space. Indeed, in other dialects the low-back vowel merger and TRAP-retraction are the first two stages of a chain shift (see, e.g., Clarke et al. 1995).

Though the low-back vowel merger is common in South Midland U.S. varieties of English (Labov, Ash, and Boberg 2006), TRAP-retraction in U.S. English dialects east of the Mississippi River has not yet been reported. If Gordon’s (2005) suggestion is correct, however, not only should we see the beginnings of TRAP-retraction in these “merged” South Midland dialects, but we are also provided with a testable hypothesis connecting the LOT~THOUGHT merger to TRAP-retraction. Specifically, if we assume that the amount to which the LOT and THOUGHT vowels have merged can be measured by the Cartesian Distance between them (Baranowski 2007), and we assume that the amount to which the TRAP vowel has retracted can be measured by the F2 value of TRAP, then a positive correlation should exist such that the F2 of TRAP increases as the Cartesian Distance between LOT and THOUGHT decreases.

In order to test this hypothesis, I present data from an emerging adult (Arnett 2000) speech community living in Southern Illinois, a region within the South Midland dialect area (for a full description, see Bigham 2008). F1 and F2 were measured for vowel tokens of the TRAP, LOT, and THOUGHT word classes (vowel key words follow the conventions of Wells 1982) taken from word list recitation and interview data for eight adult speakers from Southern Illinois. These results are compared against data from emerging adults from the Chicagoland and I-55 Corridor regions of Illinois, areas that typically do not engage in low-back vowel merger, nor in TRAP-retraction.¹

Although the data show that speakers in Southern Illinois engage in forms of both TRAP-retraction and the low-back vowel merger, the level at which these two phenomena interact presents a more complex situation. That is, while the F2 of TRAP and the Cartesian distance between LOT and THOUGHT appear to be significantly correlated at the level of the speech community, this correlation is not upheld at the level of the individual speaker, presenting a possible problem for Gordon’s (2005) suggestion of the etiology of this correlation. Additionally, while finding the low-back vowel merger in a South Midland U.S. dialect is unsurprising, the discovery of a distinctly backed TRAP vowel (often further back than the F2 grand mean) in this region is novel.

*Many thanks to Matt Gordon and Janet Fuller for suggestions and thoughts on earlier versions of this work (when it was part of my dissertation). Thanks also to participants of the Methods in Dialectology XIII and NWAV 2008 conferences where I presented parts of this work. Any errors or theoretical overstatements are, of course, my fault alone.

¹While I have reported elsewhere (e.g., Bigham 2008) on the dialect accommodation effects between these speakers (including effects on the TRAP and THOUGHT vowels), the basic conditions needed to test the hypothesis linking TRAP-retraction to the low-back vowel merger are still satisfied.

2 Background

2.1 Cultural and Linguistic Geography of Illinois

For the purposes of this paper, the linguistic geography of Illinois can be divided into three regions. The northernmost region, Chicagoland,² has been firmly established as part of the Inland North dialect area (Shuy 1962, Labov, Ash, and Boberg 2006), with speakers in the region participating in the Northern Cities Shift (NCS, hereafter). The second region, the I-55 Corridor, cuts a diagonal swath across the middle of the state, traveling from Chicago down Interstate Highway I-55, through Bloomington-Normal, until it reaches St. Louis, a once Midland city that has since adopted more NCS-like dialect features (see, e.g., Labov 2007, Labov, Ash, and Boberg 2006, Gordon 2005, Murray 1993). Although this area was initially viewed as part of the larger North Midland dialect area (Carver 1986), more recent research has shown that the NCS-like features of Chicagoland speech are spreading along this corridor down to St. Louis proper (Labov 2007). These NCS-like features, however, appear to be somewhat more haphazard and acquired by speakers in a more piecemeal fashion than they are for speakers in the Inland North. Therefore, while we can expect to find many of the hallmarks of NCS speech (raised *TRAP*, fronted *LOT*, lowered *THOUGHT*, backed *STRUT*) these features do not necessarily have the same structural relationship to one another as they do in “true” NCS dialect regions, like Chicagoland (see, e.g., Gordon 2005). Culturally, Zelinsky (1973) shows that these two areas of Illinois contain predominantly Midwestern and extended New England sociocultural influences.

The third major area of Illinois, Southern Illinois, is the least densely populated and most rural region of Illinois (Adams 1994), with settlers in the early 19th century coming from Upland South regions, like Tennessee, Kentucky, Virginia, and North Carolina (Carver 1986). Culturally, Zelinsky (1973) includes Southern Illinois with “the South”; this is echoed in both the primary cultural geography research of Gastil (1975) and summary analysis by Frazer (1987). In my work, the definition of “Southern Illinois” closely follows the definition of the “Egypt” region set by Frazer (1987), who considers Southern Illinois to be at the northern border of “Southern” dialect influence. This is contrasted by the *Atlas of North American English* (henceforth, *ANAE*; Labov, Ash, and Boberg 2006), where Southern Illinois is subsumed under the homogenous “Midlands” dialect label, though, as Preston (2003) points out, the actual sampling of speakers in Illinois’s southern-most area is non-existent and “you can’t map where you don’t go” (Preston 2003:239). The dialect of Southern Illinois is best described as a transition zone between Southern and Midland dialects, with both “southern” and “midland” dialect features.

2.2 Phonetic and Dialectological Accounts of the Low-Back Merger

The low-back vowel merger, in its fullest form, is the lack of distinction in both production and perception³ of the *LOT* and *THOUGHT* vowels, creating homophony in word pairs like *cot~caught*, *body~bawdy*, *collar~caller*, *Don~Dawn*. *ANAE* cites the low-back vowel merger as one of the two key pivot conditions for vowel shifts in North American English.⁴ Although many sources (e.g., Bailey 1968) suggest that the low-back vowel merger is achieved via the replacement of the *THOUGHT* vowel by the *LOT* vowel, Herold (1990) shows that this is not always the case: merged low-back productions take a range of forms from [ɑ] to [ɔ] depending on the speaker, the community, and the overall “degree” and “completeness” of the merger in each community. Furthermore, Herold posits a mechanism for merger dubbed “merger by approximation” (Herold 1990:62–69) whereby *LOT* and *THOUGHT* begin to merge by productions of each first expanding into the phonetic territory of the other.

Unfortunately, beyond Herold’s work, acoustic studies regarding the realization of the U.S. low-back vowel merger are sparse. Clopper et al. (2005) report finding “partial merger of [LOT and

²“Chicagoland” is defined as the greater Chicago metropolitan area: the area of Illinois that falls under the jurisdiction of the Chicago Metropolitan Agency for Planning (C.M.A.P. 2008).

³This dissertation only tested for production distinction, not perceptual distinction.

⁴The other key pivot condition is the realization of the historical “short-a” class of words.

THOUGHT]” for the dialects they label New England, Mid-Atlantic, Midland, and Western, while “[LOT and THOUGHT] were clearly distinct” for Northern and Southern dialects (Clopper et al. 2005:1667). However, these assessments are based on pairwise statistical comparison of F1 and F2 separately, which can create misleading reports on merger (as shown in Section 4, below). In addition, Majors (2005) reports that the low-back merger in Missouri may be due to the overall similarity of the dynamic formant contours of the LOT and THOUGHT vowels, while recent work by Irons (2007) suggests that the low-back vowel merger in Kentucky is accomplished by the deletion of the offglide of an already unrounded THOUGHT vowel. Irons further suggests that there may be more than one “version” of the low-back vowel merger in North American English dialects, and a review of the literature seems to support this conclusion.

As will be seen, Herold’s (1990) “merger by approximation” mechanism appears to describe the situation of LOT and THOUGHT for many Southern Illinoisans. This places Southern Illinois speakers in a state not of “transitional merger” as *ANAE* describes, where production and perception of the low-back vowels are neither clearly merged nor clearly distinct, but rather in a state of “occasional merger” where tokens of LOT and THOUGHT words are sometimes produced with the same vowel and sometimes produced with distinct vowels.

2.3 Phonetic and Dialectological Accounts of Variation in the TRAP Vowel

The TRAP vowel has also been shown to play a key role in the vowel shifts of major modern North American dialects. Labov (2001) considers the movement of TRAP to be one of the lynchpins on which many other vowel shifts depend. In NCS-like and Southern Shift-like variation, TRAP raises and fronts⁵ from an open/open-mid position to a mid/close-mid position, developing an [ɛ]-like quality; in the Canadian Shift, mentioned above, TRAP lowers and backs to an [a]-like quality while in the Northern California Vowel Shift (Eckert 2004), TRAP raises before nasals but is otherwise retracted. In typical Midland dialects, TRAP raises allophonically before nasals but not elsewhere and is otherwise unshifted. Additionally, the TRAP vowel is known as a vowel showing a great deal of internal variation, with TRAP in many dialects exhibiting two phonologically conditioned variants, such as raising before nasals, voiceless fricatives, and sometimes before /d/ (Labov 2001, Beddor 1993).

Regarding the quantitative height and backing of TRAP, *ANAE* establishes that NCS-like values for the F1 of TRAP vowels should be less than 700 Hz while Canadian Shift-like retraction of TRAP results in F2 values less than 1825 Hz. Additionally, the “EQ Criterion” compares the reversal of the F1 positions of TRAP and DRESS, where fully NCS-like shifted patterns show a complete reversal for the F1 positions of these two phonemes (Labov, Ash, and Boberg 2006). As reported in Bigham (2008), when comparing mean formant values of speaker groups (i.e., Chicagoland males, Southern Illinois males, etc.), no speaker groups are found to meet the EQ Criterion. However, when individual speakers’ tokens are assessed rather than mean values, some speakers do show the occasional reversal of tokens in the TRAP and DRESS word classes.

Among speakers from Southern Illinois, I have found that female speakers produce mostly lower and backer TRAP variants while male speakers show a tremendous range of variation, producing both quite high and quite low TRAP tokens, including raised TRAP variants that do *not* exhibit the concomitant fronting usually found with raised TRAP. Additionally, the variation of TRAP is a salient marker for the specific Northern/Southern dialect split represented among speakers analyzed here: pronunciation of TRAP is often mentioned during interviews with Southern Illinoisans when describing “how people from Chicago sound,” second only to LOT for phonological variables.

⁵NCS-like TRAP-fronting is more common in reports of St. Louis speakers, while /æ/-raising is more common in reports of other NCS dialects.

3 Methods

The speakers who provide the principal data for this investigation are 26 subjects who were undergraduates at Southern Illinois University Carbondale (SIUC) during the Fall and Spring semesters of the 2006–2007 school year (eight from Southern Illinois and nine each from the Chicagoland and I-55 Corridor regions of Illinois). All speakers indicated themselves to be white/Caucasian and were born and raised in their respective “home regions”. The age group is that of emerging adults or people experiencing emerging adulthood (Arnett 2000).

Word list recitation and interview data were collected; word list tokens were in two contexts (h_d , b_t), repeated five times; approximately three tokens of each vowel were sampled from interview speech (~39 tokens total per speaker). Vowel formants were analyzed using the auto-formant tracking of the Praat software. Settings were chosen based on the best fit (visually judged) for each individual speaker’s voice and remained constant for a given speaker. Data were normalized using a modification of the Watt and Fabricius (2002) geometric normalization technique, with some minor modifications more suited to dialects of American English;⁶ normalized Hertz values reported from this routine are in “WF units”. Because of the nature of this method, the point at 100 WF units represents the grand mean line for both the F1 and F2 axes in vowel plots.

4 Findings and Discussion

4.1 Community-level Vowel Variation

Presented first are the unnormalized mean F1 and F2 values for the TRAP, LOT, and THOUGHT vowels taken from word list data, separated according to speaker region and gender. These data are presented in Table 1; average Hertz values are listed, standard deviations are in parentheses.

Vowel	Region	F1		F2	
		Males	Females	Males	Females
TRAP	Southern Illinois	721 (41)	966 (47)	1626 (58)	1855 (54)
	I-55 Corridor	656 (64)	988 (48)	1690 (125)	1932 (87)
	Chicagoland	648 (37)	834 (60)	1744 (102)	1895 (114)
LOT	Southern Illinois	702 (70)	872(53)	1123 (61)	1300 (134)
	I-55 Corridor	694 (49)	951 (55)	1155 (60)	1472 (95)
	Chicagoland	736 (56)	909 (35)	1202 (115)	1509 (116)
THOUGHT	Southern Illinois	676 (70)	840 (29)	1055 (66)	1272 (89)
	I-55 Corridor	642 (54)	918 (38)	1030 (47)	1412 (100)
	Chicagoland	678 (33)	855 (39)	1067 (44)	1322 (119)

Table 1: Unnormalized mean F1 and F2 values.

The values above are characteristic of NCS-type vowels for Chicagoland and the I-55 Corridor, though none of the values here are as advanced as the previous literature would predict. Subjects from the I-55 Corridor appear to be the most diverse group in terms of vowel production, though the Chicagoland and Southern Illinois subjects also show a great deal of variability. In order to address the main hypothesis of this paper, however, male and female speakers need to be tested together for each regional community. Since ANOVA tests show no significant interaction between region, sex, and vowel for either F1 ($p=.7821$) or F2 ($p=.2034$), we can combine the normalized values of males and females for the remaining tests.

⁶See Bigham 2008 for a complete description of these modifications.

Addressing the main hypothesis, three figures are reported for each regional group: unpaired *t*-test results comparing the F1 and F2 of LOT and THOUGHT, the Cartesian distance between LOT and THOUGHT, and the average F2 of TRAP. These data are presented in Table 2.

First, we see that when comparing the F1 and F2 values of LOT and THOUGHT, only the Southern Illinois group shows a lack of significant difference in these values; this may be interpreted as strong evidence that these vowel classes have merged. Second, we see that this assertion is supported further by the Cartesian distance between LOT and THOUGHT among these three groups of speakers; Southern Illinoisans have less distance between these vowels than speakers from Chicagoland or the I-55 Corridor have. Although the differences between groups in the average F2 of TRAP may seem small, ANOVA confirms that these differences are significant ($p=.007$).

	Unpaired <i>t</i> -test comparing LOT and THOUGHT		Cartesian distance of /a/~/ɔ/	Avg. F2 of TRAP
	F1	F2		
Southern Illinois	.1759	.3179	8.8	107.0
I-55 Corridor	.0039*	.0057*	16.5	111.6
Chicagoland	.0038*	.0009*	21.0	115.6

Table 2: Comparison and distance of LOT~THOUGHT; average F2 of TRAP.

When viewed as a whole, then, these data obtain the expected correlation between the F2 of TRAP and the Cartesian distance between LOT and THOUGHT ($r=.48$, $p=.01$). That is, these data appear to confirm the hypothesis that TRAP retracts as a function of the merger of LOT and THOUGHT; TRAP is most retracted for Southern Illinoisans and least retracted for Chicagoland. These data provide precisely the confirmatory evidence needed to verify Gordon's (2005) claim.

These data, however, are based on the aggregate values across all speakers within each group and the ways in which individual speakers merge or maintain separation in the LOT and THOUGHT vowels is highly variable. However, if TRAP retracts *because of* the merger of LOT and THOUGHT, then we should also expect to find a correlation between the F2 of TRAP and the Cartesian distance of LOT and THOUGHT at the level of individual speakers as well. Therefore, what is needed is a comparison of the LOT, THOUGHT, and TRAP vowels as each individual speaker produces them.

4.2 Individual-Level Vowel Variation

Since a full Cartesian analysis of each set of vowels produced by every speaker would be monstrously large (5!x5!x5!x26 comparisons), we now switch to an impressionistic categorization of the low-back vowel merger. Because we cannot expect that all speakers who merge LOT and THOUGHT do so in precisely the same ways, three broad categories of merger were chosen—*distinct*, *occasional*, and *merged*—and each speaker was assigned to one of these three categories. Word list recitation and interview data were evaluated by both me and my research assistant and together we assigned each speaker to his or her merger category.

For *distinct* speakers, tokens of LOT and THOUGHT were reliably produced with the expected phonetic form, broadly evaluated. That is, LOT-class words were produced with something [a]-like and THOUGHT-class words were produced with something [ɔ]-like. However, even some of the “distinct” speakers occasionally produced [ɔ] for LOT-class words or [a] for THOUGHT-class words; these “transgressions” were overall quite infrequent for these speakers. See Figure 1.

For *occasional* speakers, tokens of LOT and THOUGHT were produced with either [a]-like or [ɔ]-like phonetic forms, in a seemingly random way. The exact form of this “randomness” varied from speaker to speaker, with some favoring [ɔ]-like pronunciations, some favoring [a]-like pronunciations, some producing LOT tokens reliably but varying in pronunciation of THOUGHT tokens, and some producing THOUGHT tokens reliably but varying in pronunciation of LOT tokens. While a deeper analysis may lead to patterns that distinguish these varying kinds of “occasional” merger, they are not separated for the purpose of analysis here. See Figure 2.

For *merged* speakers, tokens of LOT and THOUGHT vowels were indistinguishable by either me or my research assistant. Although my assistant and I were in agreement as to which speakers were participating in the low back merger and which were not, we did not always agree on the phonetic realization of this merged sound. While my assistant consistently heard this merged vowel as [ɑ]-like, I heard more variation, with most merged speakers producing something I might call “unround dropped-[ɔ],” a form more like [ɔ] than [ɑ] in my opinion, but not entirely similar to either. For analysis purposes, again, these possible variations were collapsed into the single “merged” category. See Figure 3.

As Figures 1, 2, and 3 show, there is considerable variation between individual speakers on how and where tokens of the LOT and THOUGHT vowel classes are produced. Next, in Figure 4, a comparison of where speakers from each of these three groups produce tokens of the TRAP vowel is provided. In Figure 4 we see that most of the retracted tokens of TRAP are produced by those speakers who have merged the LOT and THOUGHT vowels, while more of the unretracted TRAP tokens are produced by speakers who either maintain distinction between LOT and THOUGHT or only participate in the low-back merger occasionally. This is in line with both the original hypothesis and the findings from the community-level data. However, we can also see that this is by no means a categorical distinction: TRAP tokens from speakers with the low-back vowel merger can be produced unretracted (even slightly raised and fronted), while even speakers who do NOT participate in the low-back vowel merger may produce a retracted TRAP vowel.

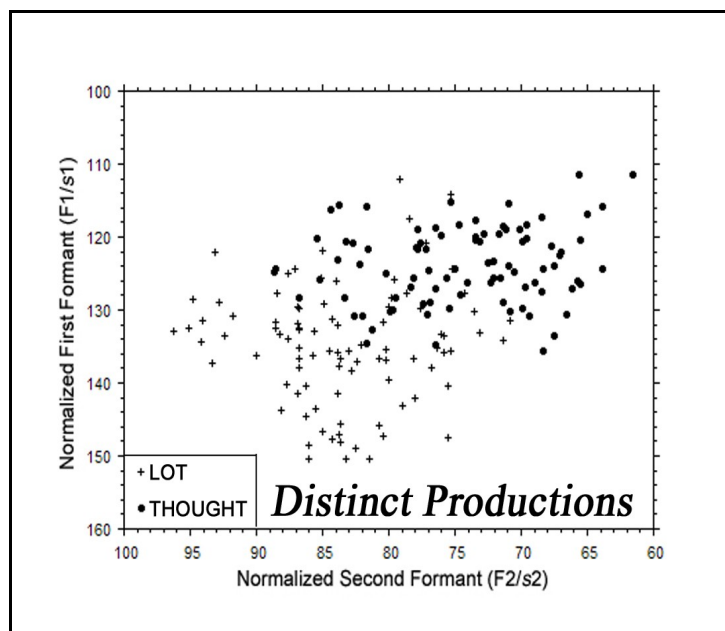


Figure 1: Productions of LOT and THOUGHT tokens for speakers who maintain distinctions between these two vowel categories.

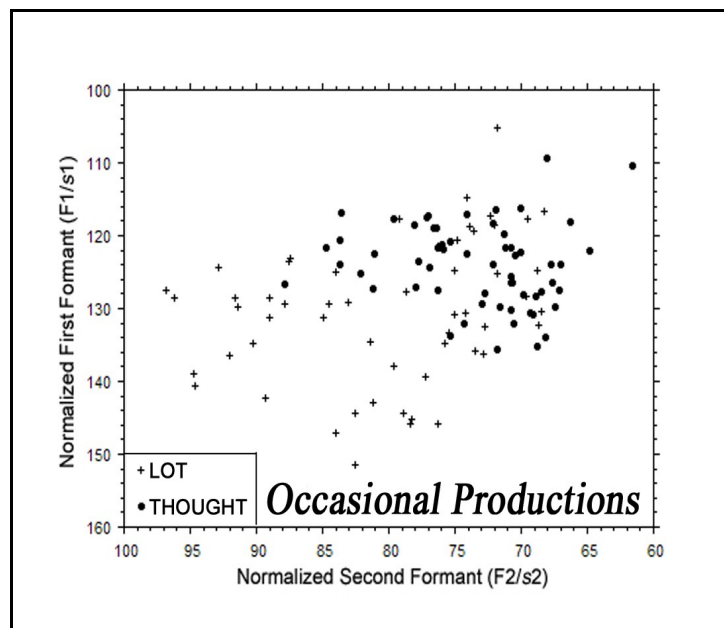


Figure 2: Productions of LOT and THOUGHT tokens for speakers who occasionally merge these two vowel categories.

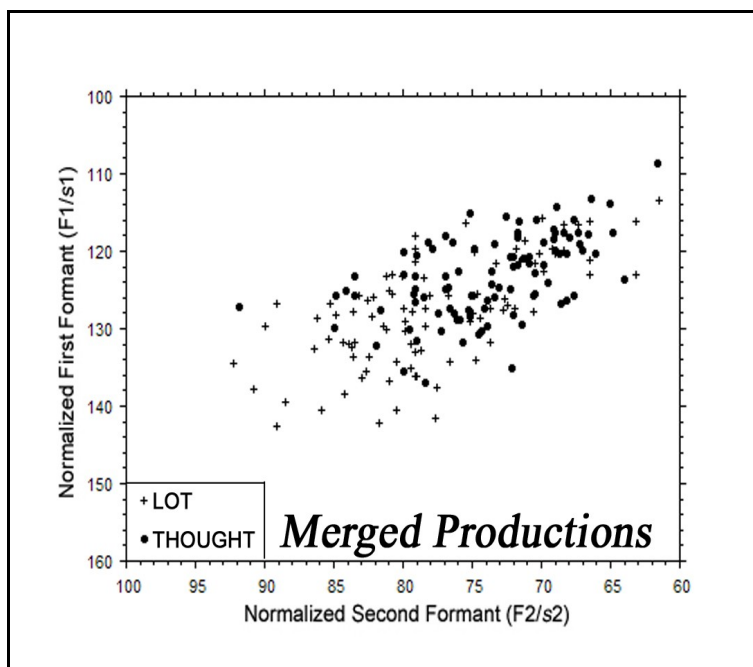


Figure 3: Productions of LOT and THOUGHT tokens for speakers who have merged these two vowel categories.

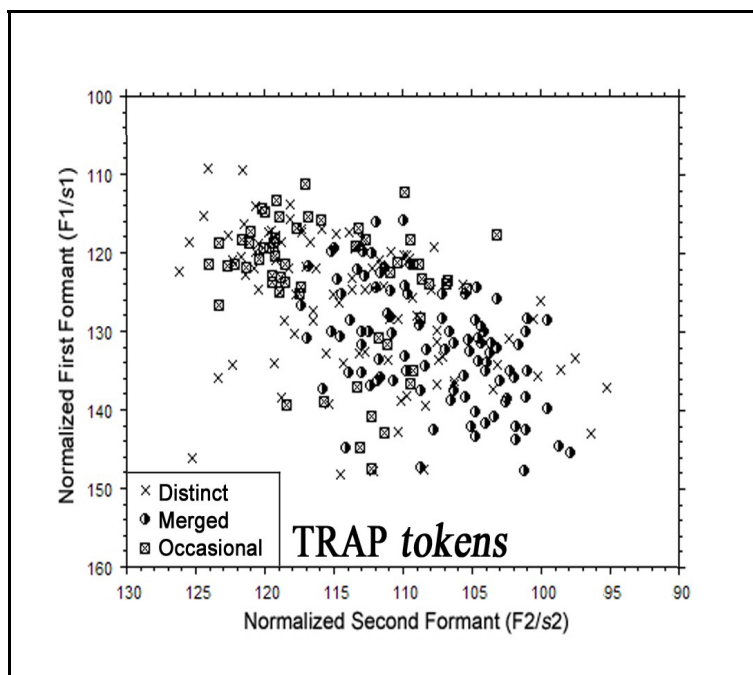


Figure 4: Productions of TRAP vowel tokens separated according to how a speaker produces the LOT and THOUGHT vowels.

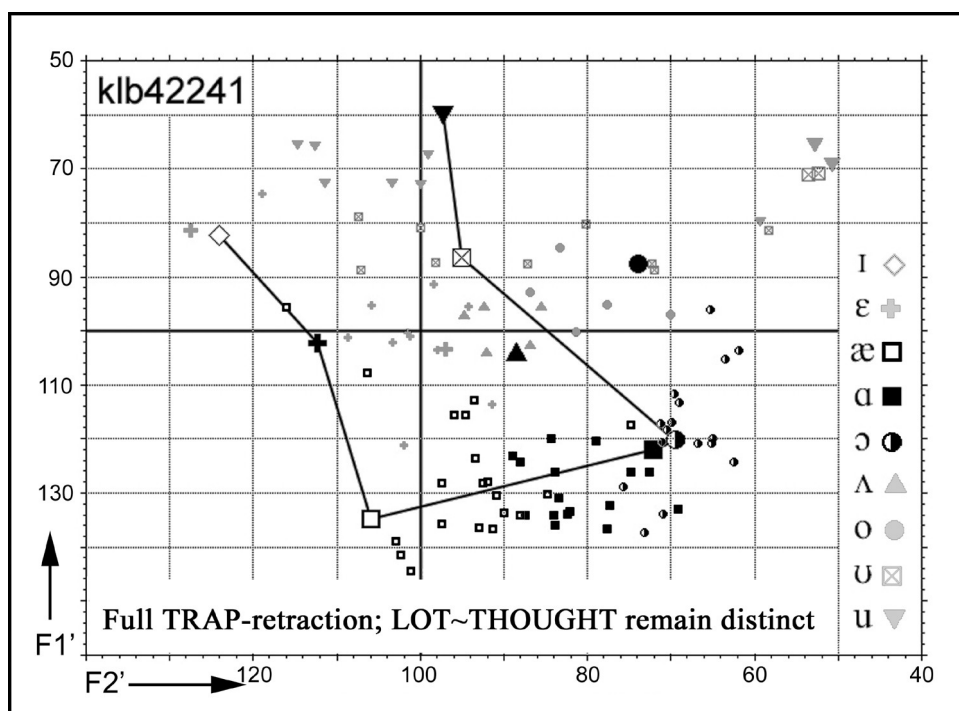


Figure 5: Speaker *klb42241*: TRAP-retraction while maintaining LOT~THOUGHT distinction.

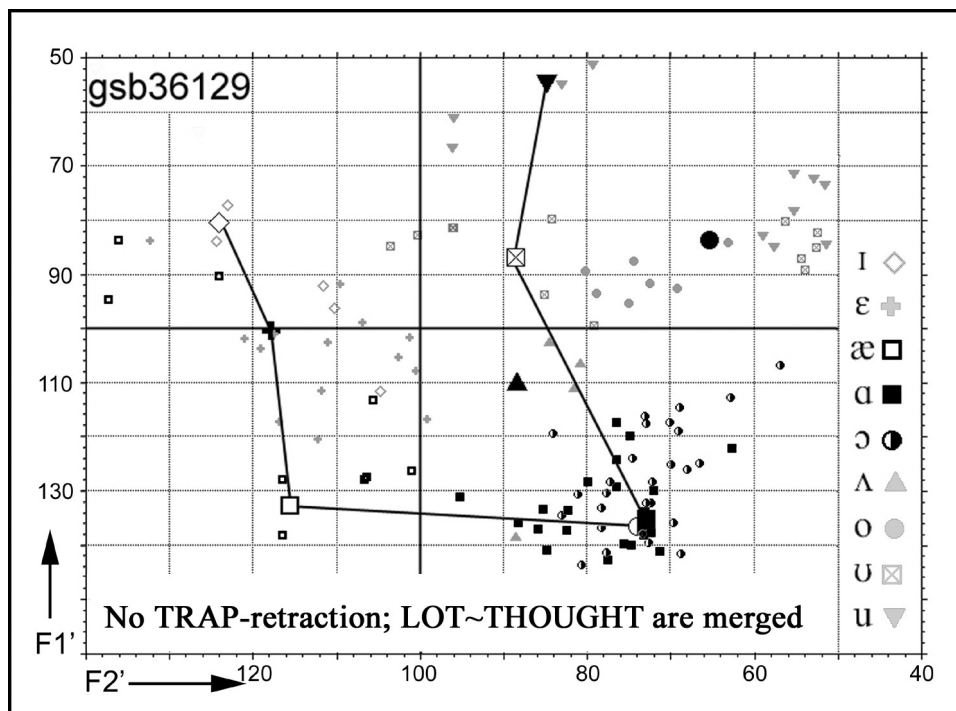


Figure 6: Speaker *gsb36129*: full LOT~THOUGHT merger with no evidence of TRAP-retraction.

Finally, this disjunction between TRAP-retraction and the merger of LOT and THOUGHT can be seen quite clearly when looking at the vowel productions of individual speakers, as seen in Figures 5 and 6. Both speakers are 18-year old males from Southern Illinois; data points from additional vowels are provided for reference. In Figure 5 we see that speaker *klb42241* shows extensive evidence of TRAP-retraction while still maintaining distinction between LOT and THOUGHT. If TRAP-retraction were solely based on the margin of security generated by the LOT~THOUGHT merger, how is it that this speaker can produce retracted TRAP without causing a homonymic clash with LOT? For *klb42241* the supposed “margin of security” does not appear to exist. Conversely, in Figure 6, we see the opposite pattern: speaker *gsb36129*, who has fully merged the LOT and THOUGHT vowels, but who shows no evidence of TRAP-retraction.

4.3 The difference Between Individual and Community-level Variation

What the data presented in Figures 4, 5, and 6 suggest, then, is that although Gordon’s (2005) hypothesis is confirmed at the community-level, it is disconfirmed at the level of the individual speaker. Elsewhere (Bigham 2008), I have suggested that this apparent clash can be explained by disentangling the individual and community level phonetic systems via a model of language change based on the principles of evolution and emergence (the “evolutionary-emergence model”). Briefly, this model suggests that while language variation exists at the level of individual speakers (following Milroy 1992), language change and structural vowel shifts exist at the level of the speech community as aggregate and emergent properties of individual-level variation. However, by crucially considering the interaction between interlocutors, i.e., two or more *individuals* acting as a *community*, we can explain not only why we find disjoints such as those reported here, but why, in fact, we *should* find these apparent contradictions.

For example, Southern Illinoisans, as a community, participate in the low-back vowel merger. Therefore, we can expect that any given individual from that community will, more likely than not, participate in the low-back vowel merger. Since individual speakers in Southern Illinois will be communicating most often with interlocutors who are also from Southern Illinois, any given Southern Illinoisan will be engaged in any given conversation more often than not with a speaker

who participates in the low-back vowel merger (this assumption is related to Labov's 2001 *principle of density*). Therefore, any given Southern Illinoisan has more room to vary the TRAP vowel in the F2 dimension because it will likely not interfere with *interlocutor perception*.

Consequently, it should be more common than not to find Southern Illinois speakers who produce retracted forms of TRAP, regardless of whether these speakers participate in the low-back vowel merger themselves. That is, Southern Illinoisans can freely "back their /æ/s up" without fear of being misunderstood. Over time, a bottom-up feedback loop from individual to community back to individual is generated that minimizes this production/perception disjoint. However, in early stages of change and/or in dialect contact situations, we are able to "capture" this emergent process before the system "re-stabilizes". Therefore, though TRAP-retraction and the low-back merger can be "decoupled" in any given individual speaker, a correlation still emerges at the level of a community of speakers. While not yet fully tested, the *evolutionary-emergence model* of language change can be seen as building upon Croft's (2000) description of the lingueme pool, Labov's (1994) description of probability matching, and Lindblom's principle of maximal dispersion and H&H theory of speech perception (1990, see also Lindblom et al. 1995).

Gordon's (2005) original hypothesis is that TRAP retracts as a function of the margin of security created when LOT merges with THOUGHT. In this work, I have shown that while this theory holds up at the level of the speech community, it must be revised when looking at the speech of individual speakers. I have suggested that one such model, the evolutionary-emergence model of Bigham (2008), may be able to account for the difference between community-level and individual-level findings regarding linguistic variation. It is only with additional study of the phenomena described here, as well as additional application and testing of various models of language change, that we may finally reach a conclusion.

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