2. DIMENSIONS OF VARIANCE AND CONTRAST IN THE LOW BACK MERGER AND THE LOW-BACK-MERGER SHIFT

JAMES GRAMA *and* ROBERT KENNEDY

In keeping with the work in this volume (Becker 2019), we investigate the relationship between the Low Back Merger and the Low-Back-Merger Shift (LBMS), specifically to determine whether overlap of the low back vowels bot and bought precipitates lowering and backing of the short front vowels bit, bet, and bat or whether the two phenomena are coincidental.[1] We draw upon elicited and conversational interview data from contemporary young Californians, one of the North American varieties of English closely identified as a locus of the coincidence of the merger and the shift.

While we can demonstrate a principled link between the Low Back Merger and the LBMS, we also suggest that a more nuanced understanding of the two phenomena is warranted. Notably, we find speakers who are variable in the extent of their low back vowel overlap, yet still participate in the LBMS, suggesting that completion of the merger is not a prerequisite for the initiation of the shift. In short, we align with the account presented in this volume that the Low Back Merger is the initiator of the LBMS and that the movement of bot—not full merger—is enough to trigger shift. In addition, we show that the positions of the low vowels bat, bot, and bought are more variant than bet and bit. Finally, we consider the structural and historical reasons behind the prevalence of the Low Back Merger and why it is a trigger for the LBMS. We posit that the merger and subsequent bat backing are products of acoustic or perceptual instability. Drawing on cross-dialectal comparisons, we speculate that our academic framing of the emergence of merged and unmerged Englishes ought be seen not as a function of divergence from some erstwhile unmerged monolith, but as the product of a typology of varieties across which the low back vowel space was never stable in the first place.

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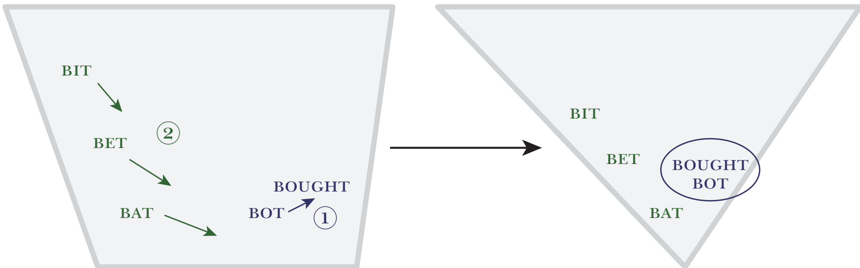
DEFINING THE LOW BACK MERGER AND THE LOW-BACK-MERGER SHIFT

We define the LOW BACK MERGER as the trait of any variety in which there is no more than one clear phonemic category observable among vowels clustering toward the articulatory low back vowel space.[2] In such varieties, words in the BOUGHT set—such as *caught*, *bought*, *hawk*, and *dawn*—are homophonous, respectively, with words in the BOT set—such as *cot*, *bot*, *hock*, and *don*. Conversely, low back contrast applies to any variety in which the two vowel classes maintain distinct phonemic categorization. Within North America, the Low Back Merger is a notable feature of Englishes in Canada and California, but it is certainly not limited to these regions. Other western varieties (Fridland and Kendall 2019 [this volume], Swan 2019 [this volume], among others) show evidence of the same phenomenon, as does the Midland (Durian 2008, 2012; Bigham 2010; Kohn and Stithem 2015; Strelluf 2019 [this volume]), the Inland North (Olsaker 2013; Nesbitt, Wagner, and Mason 2019 [this volume]), and the South (Gentry 2006; Doernberger and Cerny 2008). In addition, merger is evidenced in New England (Kurath 1939–43; Boberg 2001; Labov, Ash, and Boberg 2006; Johnson 2010; Stanford, Leddy-Cecere, and Baclawski 2012) and western Pennsylvania, centered on Pittsburgh (Labov, Ash, and Boberg 2006; Eberhardt 2008; Labov 2019 [this volume]). However, the Low Back Merger is far from ubiquitous in the Englishes of North America. The Inland North, the Northeast excluding northern New England, and more conservative varieties of Southern and Midland varieties maintain low back contrast (Labov, Ash, and Boberg 2006).

A second crucial working definition to establish is the parameters for the LOW-BACK-MERGER SHIFT. This is a phenomenon in which the three phonologically short front vowels of English are relatively lower and more backed compared to their configuration in other varieties of English, as in figure 2.1. As such, the vowels of BIT, BET, and BAT roughly move from [ɪ, ɛ, æ] to positions respectively closer to [ɛ, æ, a].

This reordering has been alternately called the Canadian Vowel Shift (Clarke, Elms, and Youssef 1995; Boberg 2005, 2008, 2010; Sadlier-Brown and Tamminga 2008; De Decker 2010), the California Vowel Shift (Hinton et al. 1987; Luthin 1987; Eckert 2008; Podesva 2011; Fridland and Kendall 2012; Kennedy and Grama 2012; Hall-Lew 2013; Podesva et al. 2015; Cardoso et al. 2016; D'Onofrio et al. 2016; Janoff 2018), the Third Dialect Shift (Labov 1991; Kohn and Stithem 2015), and the Short Front Vowel Shift (Boberg 2019). In keeping with the rest of the volume, we adopt the term Low-Back-Merger Shift (LBMS) and attest that the range of names for the phenomenon reflects the range of varieties in which it has been detected.

FIGURE 2.1
A Schematic of the Low Back Merger and the Low-Back-Merger Shift (Becker 2019 [this volume], 1)



Moreover, despite differences in the specific phonetic realizations of the vowels involved, in every case the shift affects the same categories with the same general trajectory. We discuss our measured support for the moniker Low-Back-Merger Shift in the conclusion of this chapter.

CURRENT STUDY

The current study hinges on the observation that previous research on the LBMS demonstrates variability in low back vowel space. As such, we conduct a series of analyses that explore the link between the Low Back Merger and the LBMS. We analyze novel data to test for the presence of the front vowel shift and low back overlap and for objective correlations between the two phenomena.

In this section we demonstrate that (1) while our subjects as a group exhibit the Low Back Merger, they vary in the extent of this overlap; (2) our subjects meet the basic criteria for the LBMS; and (3) the position of BOT rather than strict overlap between BOT and BOUGHT is correlated with the LBMS.

SUBJECTS AND METHODS. Data were drawn from sociolinguistic-style interviews conducted in 2010 with 44 native Californians (23 men and 21 women) of various ethnic backgrounds between the ages of 18 and 35 in various metropolitan areas across the state.[3] Of these 44 speakers, 35 hailed from places generally regarded as "SoCal" (San Diego, the greater Los Angeles area, Santa Barbara County, and San Luis Obispo). The remaining interviews were collected from speakers in the San Francisco Bay area, Sacramento, and Redding ("NorCal"). The interviews were chiefly conducted in participants' homes or in places they reported feeling comfortable speaking freely. All participants were born and raised in California, and no speakers reported living for more than six consecutive months outside the state. The interviews consisted of a series of tasks, two of which provide the data for analysis in this study: a read word list and a semistructured conversation following a list of questions about schooling, movies, music, state culture, politics, and religion. Our word list data provides a high degree of control over phonological and phrasal factors, which can play a role in the production of vowels (see, e.g., Kirtley et al. 2016). To bolster our results, conversational speech was analyzed from a subset of 16 speakers whose recordings were long enough to facilitate analysis.[4] All recordings were carried out using a Tascam DR-05 using a sampling rate of 44.1 kHz.

Vowels from the word list were hand-aligned in Praat, and spontaneous speech data was taken from unbroken 20-minute sections from the 16-interview subset. These interviews were transcribed and time-aligned in Transcriber (Barras et al. 2001) and then force-aligned at the segment level using the HTK toolkit in LaBB-CAT (Fromont and Hay 2013) and *The CMU Pronouncing Dictionary* (2013). A maximum of five tokens per lexeme were extracted for analysis from all vowel categories produced in stressed content words. Function words and vowel realizations before /ɹ/ and /l/ were excluded from all analyses. Prenasal tokens were included but coded separately and do not factor into the analysis here. The accuracy of alignment was hand-checked by the first author (Grama), and a Praat script was used to extract the first two formants at the midpoint of the vowel, as well as vowel duration. This process yielded 2,402 word list tokens and 11,268 conversational tokens of BIT, BET, BAT, BAN, BOT, and BOUGHT. Vowels were then normalized on the basis of the entire vowel space using Lobanov's (1971) method to ensure maximum comparability across the studies discussed in this volume, as well as those in the literature.

EVIDENCE OF LOW BACK MERGER. We first consider whether the Low Back Merger is robust in our data. Figure 2.2 shows the distribution of normalized midpoint values of low back vowels in word list and conversational contexts. As a population, our subjects show convincing overlap between BOT and BOUGHT. Post-hoc comparisons of ANOVAs fit separately to normalized F1 and F2 corroborate no clear difference in the means of BOT and BOUGHT in either word list or conversation contexts (see table 2.1).

Despite the apparent overlap of BOT and BOUGHT, further investigation suggests that a degree of low back contrast remains for some speakers. Overlap was assessed between the low back vowels using Pillai scores derived from separate MANOVAs fit to each speaker's BOT and BOUGHT tokens separately for word list and conversational contexts (Hay, Nolan,

FIGURE 2.2

Normalized Distributions of BOT and BOUGHT with Ellipses at 95% Confidence Intervals in Word List and Conversation Contexts

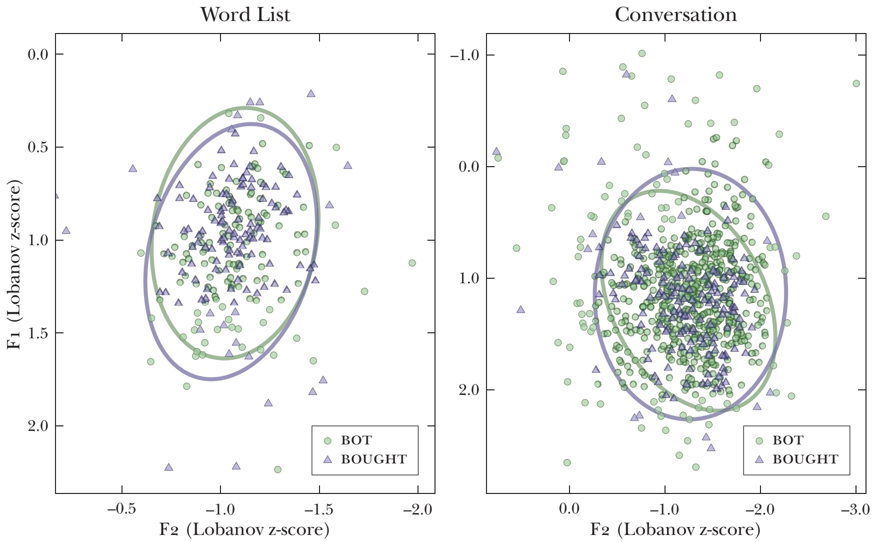


TABLE 2.1

Post-Hoc Comparison of Normalized F1 and F2 of BOT and BOUGHT

	BOT	*BOUGHT*	*Difference*	*p-Value*
Word List				
F1	1.078	0.995	0.082	.635
F2	–1.065	–1.076	0.011	.999
Conversation				
F1	1.182	1.134	0.048	.999
F2	–1.202	–1.320	0.118	.710

and Drager 2006; Hall-Lew 2009, 2010; Nycz and Hall-Lew 2014). The distribution of Pillai scores calculated from the word list data is shown in figure 2.3, where lower Pillai scores correspond to more spectral overlap, indicating merger. Of note, these speakers exhibit a range of values indicating variability in the extent of the Low Back Merger, irrespective of gender or region, broadly defined. Separate ANOVAs fit to Pillai scores with region and gender as predictors corroborates this, returning no significant effects (gender: $F(1, 42) = 2.602$, $p = .114$; region: $F(1, 42) = 1.124$, $p = .295$).

Table 2.2 shows the distribution of Pillai scores from the subset of speakers with data in both word list and conversational contexts. While

FIGURE 2.3
Violin Plots with Speaker Pillai Scores from Wordlist Data across Gender and Region

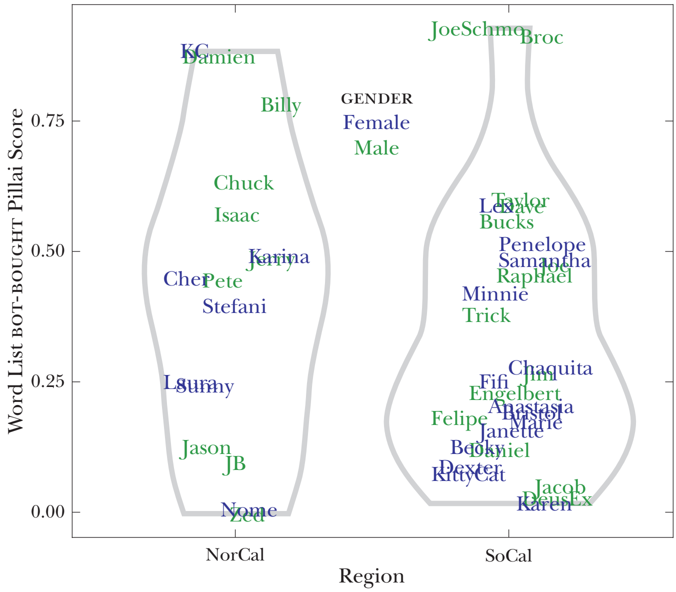


TABLE 2.2
BOT-BOUGHT Pillai Scores for Subsample of 16 Speakers in Word List and Conversation Contexts

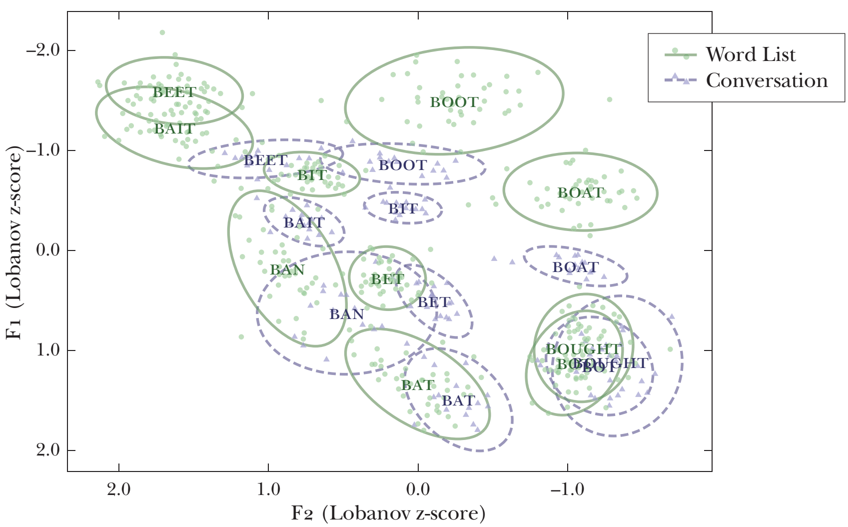
Speaker (sex, region)	*Pillai (wordlist)*	*Pillai (conversation)*	*Change*
Deus Ex (m, Los Angeles)	0.03	0.01	–0.02
Jacob (m, Fontana)	0.03	0.01	–0.02
Janette (f, San Diego)	0.11	0.08	–0.03
Fifi (f, Anaheim)	0.25	0.22	–0.03
Daniel (m, Los Angeles)	0.20	0.03	–0.17
Anastasia (f, San Diego)	0.24	0.06	–0.18
Jason (m, Sacramento)	0.19	0.01	–0.18
Becky (f, Los Angeles)	0.23	0.03	–0.20
Bristol (f, Los Angeles)	0.24	0.03	–0.21
Joe (m, Ventura)	0.50	0.28	–0.22
Laura (f, Sacramento)	0.25	0.02	–0.23
Nome (f, Sacramento)	0.52	0.23	–0.29
Minnie (f, Ventura)	0.40	0.06	–0.34
Samantha (f, Santa Barbara)	0.45	0.03	–0.42
Broc Sampson (m, Los Angeles)	0.90	0.28	–0.62
KC (f, Los Angeles)	0.87	0.02	–0.85

conversational Pillai scores are more tightly clustered around low values, indicating Low Back Merger, speakers still show moderate spreading of values between 0 and 0.3. Without exception, all speakers exhibit lower BOT-BOUGHT Pillai scores in conversational contexts than in word list contexts, though the magnitude of this difference varies considerably. Some speakers (e.g., DeusEx, Bristol, and Jacob) exhibit no functional difference between the two contexts, indicating complete merger irrespective of speech type, while others (e.g., BrocSampson and KC) exhibit near-categorical differences between the two contexts. This finding indicates that, for at least some speakers, the Low Back Merger is more likely to arise in conversational contexts, even if a distinction is maintained in more careful contexts.

Taken together, data from both word lists and conversations suggest a similar picture. While the overall population exhibits a clear tendency toward Low Back Merger, speakers vary demonstrably in the extent of this overlap, and there are several speakers who fall short of complete Low Back Merger.

EVIDENCE OF THE LBMS. Figure 2.4 shows the distribution of normalized midpoint values of vowels taken from word list and conversational contexts plotted in F1/F2 space. Each plot point is a within-subject mean of a vowel category. Visual inspection corroborates that most of our subjects meet the

FIGURE 2.4
Normalized F1/F2 Means of Within-Speaker Midpoints
from Word List and Conversation Contexts



criteria for the LBMS. As expected, the vowel space is compressed in conversational contexts relative to word list contexts; however, similarities arise across both speech types. The distributions of BOT and BOUGHT are clearly overlapping. BAT is the lowest vowel in the vowel space for the population, and BET is visibly lowered along the front diagonal relative to either BAN or BAIT. In addition, BIT exhibits a relatively lower and backer position relative to either BEET or BAIT in the word list data, though this appears largely due to the raised and fronted position of BAIT.

To make our data comparable to other studies in this volume and to follow best practices for future work on the LBMS, we calculated the LBMS Index for each subject using methods adapted from Boberg (2019) and described in Swan (2019 [this volume]). The LBMS Index provides a general measure of the distance between the short front vowels and the position of BEET (i.e., the high front corner of the vowel space, away from which the vowels involved in the LBMS are moving). Formulas to derive the LBMS Index are given below: Euclidean distance is calculated in equation 1, where d is the distance between BEET (v_1) and each of the three short front vowels, BIT, BET, and BAT (v_2), and the LBMS Index, calculated in equation 2, is expressed as the average Euclidean distance between BEET and each of the three short front vowels.

1. $d_{v_1\text{-}v_2} = \sqrt{(\mathrm{F2}_{v_1} - \mathrm{F2}_{v_2})^2 + (\mathrm{F1}_{v_1} - \mathrm{F1}_{v_2})^2}$

2. $\text{LBMS Index} = \dfrac{d_{\text{BEET-BIT}} + d_{\text{BEET-BET}} + d_{\text{BEET-BAT}}}{3}$

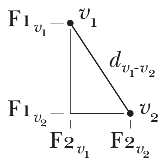
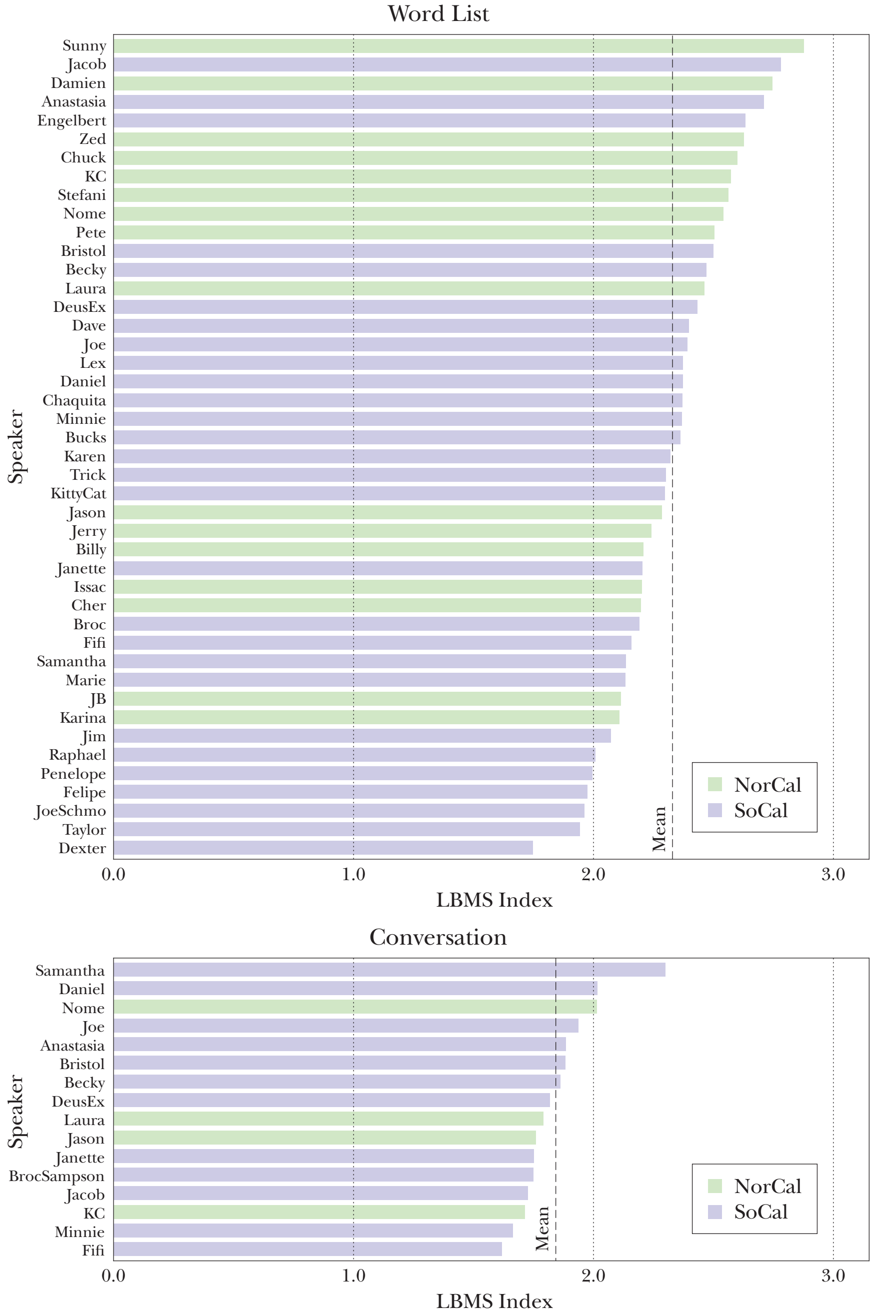


Figure 2.5 shows the LBMS Index for each speaker across speech type and region, with dotted lines indicating mean indices from word lists ($M = 2.33$, $SD = 0.25$) and conversations ($M = 1.85$, $SD = 0.17$). An ANOVA indicated significant differences between indices across speech type ($F(1, 58) = 51.40$, $p < .0001$), corroborating patterns evident in figure 2.4. Investigating each speech type separately reveals a small effect of region in the word list data, whereby NorCal speakers exhibit higher indices than SoCal speakers ($F(1, 42) = 4.22$, $p = .046$); no such effect emerges for the conversational data, likely due to the smaller sample of NorCal speakers ($F(1, 14) = 0.11$, $p = .75$). Males and females did not significantly differ from each other in either context (wordlist: $F(1, 42) = 0.06$, $p = .81$; conversation: $F(1, 14) = 0.02$, $p = .89$).

While analysis suggests that our subjects generally adhere to both the LBMS and the Low Back Merger, some aspects of the data warrant additional investigation. For example, the vowels of BIT and BET in general appear more tightly clustered—potentially leading to the observation that

FIGURE 2.5
Low-Back-Merger Shift Index for NorCal and SoCal Speakers with Lobanov Normalized Data



they are more reliably shifted than the low vowels of the shift—while the low vowels are ostensibly more scattered across both F1 and F2. This is consistent with our previous observations of wider variability in BAT compared with either BIT or BET. In Kennedy and Grama (2012, 49), we found a gender effect that differentiated the mean formants of BAT but not BIT or BET. Moreover, despite the apparent overlap of BOT and BOUGHT, both categories are visibly scattered, suggesting comparably more variation across subjects, variance that potentially masks some degree of latent low back contrast.

Indeed, the difference in variance across categories itself seems relevant. To confirm our observations of the visualized plots, we employed *F*-tests (Snedecor and Cochran 1989) to compare variance across categories of vowels, checking whether the low vowels are more robustly scattered in either formant dimension relative to upper short vowels.

In short, these variance tests show that low vowels are more scattered in F1/F2 space than higher front vowels; specifically, BAT, BOT, and BOUGHT all show more variance across subjects than BIT or BET. In word list data, BOT, BOUGHT, and BAT have significantly more variance in F1 than both BIT and BET, while BAT is more variant than BET in F2. The relatively higher variance for BOT and BOUGHT holds up in conversational data, where BOUGHT is more variant than BIT and BET in both dimensions, while BOT is more variant than BIT. These results are summarized in table 2.3. Here, the ratio of variances for two categories is presented as an *F*-statistic. Higher ratios indicate a larger difference in scatter between the two categories.

These variance tests contribute to a portrait of the California vowel space in which low vowel realizations are demonstrably more variant than the upper vowels of the short front shift, despite the established observation in the literature that BIT and BET constitute the tail end of the shift. Indeed, it is curious that the low back space and the distribution of BAT are more variant: the latter stages of this series of changes are more consistent than the earlier establishing conditions. We address the implications of these findings in the discussion.

The discussion of variance in low vowels highlights that the configuration of low back vowels may correlate with formant dimensions of the upper vowels, despite the more tightly distributed nature of the latter. We investigate these issues with a series of tests in the next section.

CORRELATING LOW BACK MERGER WITH THE LBMS. A central question is whether the Low Back Merger is structurally connected to the rotation of the short front vowels, the LBMS. Since the rotation of these front vowels is generally assumed to be linked with the suspension of contrast in

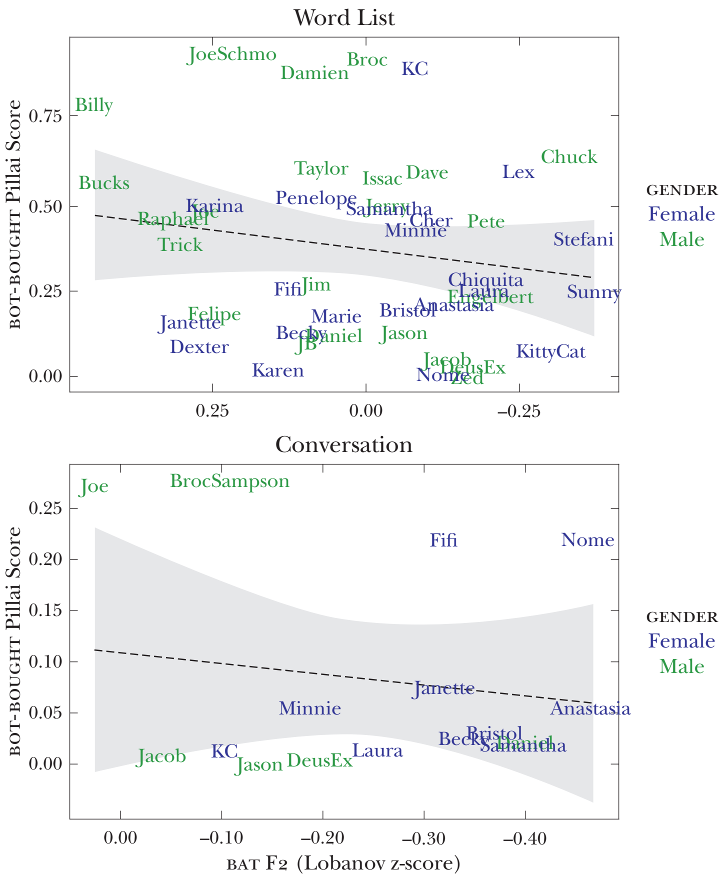
TABLE 2.3
Variance Tests

		Vowel Variance	Ratio of Variances	p-Value
Wordlist Data				
	F1	BOUGHT > BIT	$F = 3.75$	$p < .0001$
		BOUGHT > BET	$F = 3.12$	$p = .0002$
		BOT > BIT	$F = 3.20$	$p < .0001$
		BOT > BET	$F = 2.71$	$p = .0014$
		BAT > BIT	$F = 3.12$	$p = .0003$
		BAT > BET	$F = 2.64$	$p = .0019$
	F2	BAT > BIT	$F = 1.60$	$p = .1256$
		BAT > BET	$F = 2.77$	$p = .0011$
Conversational Data				
	F1	BOUGHT > BIT	$F = 13.66$	$p < .0001$
		BOUGHT > BET	$F = 3.57$	$p = .0188$
		BOT > BIT	$F = 3.57$	$p = .0003$
		BOT > BET	$F = 1.96$	$p = .2031$
	F2	BOUGHT > BIT	$F = 3.63$	$p = .0173$
		BOUGHT > BET	$F = 3.36$	$p = .0259$
		BOT > BIT	$F = 2.56$	$p = .0790$
		BOT > BET	$F = 2.36$	$p = .1063$

low back space, it stands to reason that the degree of overlap would be correlated with rotation of BAT—the lead short front vowel in the LBMS. Figure 2.6 plots BOT-BOUGHT Pillai scores against normalized F2 of BAT in both word list and conversational contexts. Several observations emerge from this comparison. First, women exhibit backer realizations of BAT than men, matching observations from the literature (Eckert 2008; Podesva et al. 2015). Second and more importantly, there is no strong relationship between BOT-BOUGHT Pillai score and BAT backing. Separate linear fixed-effects models fit to word list and conversation data corroborate this observation; BOT-BOUGHT Pillai score fails to reach significance in either word list ($\beta = 0.10$, df = 41, $t = 0.811$, $p = 0.422$) or conversation contexts ($\beta = 0.132$, df = 13, $t = 0.392$, $p = 0.702$). In addition, gender only reaches significance in the model fit to conversational data ($\beta = -0.177$, df = 13, $t = -2.583$, $p = 0.023$), not word list data ($\beta = -0.087$, df = 41, $t = -1.344$, $p = 0.186$), indicating that the gender effect on BAT backing is restricted to less controlled contexts in our sample.

Focusing on speakers, it is further evident that the Low Back Merger does not drive the extent to which BAT is backed. For example, Chuck (a man from Santa Rosa) exhibits a Pillai score of 0.63, while at the same time

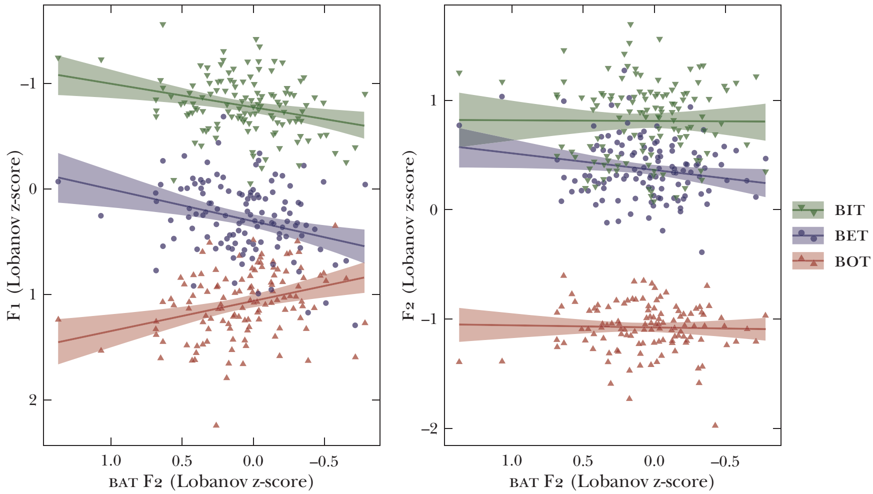
FIGURE 2.6
Normalized BAT F2 Plotted against BOT-BOUGHT Pillai Scores in Word List and Conversation Contexts for Women and Men



showing the third most backed BAT in the word list data. And Jacob (a man from Fontana) exhibits a low Pillai score, indicative of high BOT-BOUGHT overlap, while producing a relatively conservative mean F2 for BAT in the conversation data. Moreover, several speakers with Pillai scores above 0.5 in word list data nevertheless exhibit BAT backing characteristic of the LBMS. This finding supports the position that speakers can participate in the characteristic aspects of the LBMS without full instantiation of the Low Back Merger.

Although Pillai score is not a good predictor of BAT backing, a strong correlation exists between the position of BOT and the elements of the LBMS. Figure 2.7 plots F2 of BAT against F1 and F2 of BIT, BET, and BOT for

FIGURE 2.7
F2 of BAT Plotted against F1 and F2 of LBMS Vowels

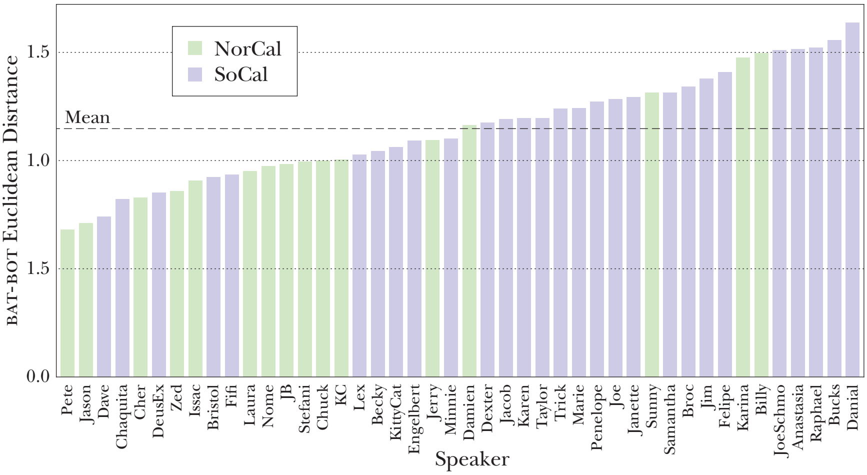


word list items preceding /t, d/. The position of BAT is correlated to the position of the other vowels in the LBMS. As BAT backing increases, BIT lowers, BET lowers and backs, and BOT raises. To corroborate these observations, we used lme4 (Bates et al. 2015) in R (R Core Team 2018) to fit a linear mixed-effects model to F2 of BAT with F1 and F2 of BOT, BET, and BIT as predictors, and speaker as a random intercept.[5] Table 2.4 shows the output of this model; degrees of freedom and *p*-values are derived with Kenward-Roger approximation using pbkrtest (Halekoh and Højsgaard 2014). The height of both BET and BOT are significantly correlated with BAT backing, as is the backing of BET; BIT fails to return significance in either formant dimension, but the effect in F1 is in the expected direction. No relation-

TABLE 2.4
Results from the Linear Mixed-Effect Model Fit to BAT F2, with F1 and F2 of LBMS Vowels as Predictors and Speaker as a Random Intercept

Predictor	*Estimate*	*t-Value*	*p-Value*	*df*
(Intercept)	–0.159	–0.794	0.429	117
F1 (BIT)	–0.125	–1.379	0.171	100
F2 (BIT)	–0.034	–0.304	0.762	98
F1 (BET)	–0.191	–2.195	0.030	103
F2 (BET)	0.086	0.681	0.497	106
F1 (BOT)	0.259	2.700	0.008	118
F2 (BOT)	–0.033	–0.253	0.801	116

FIGURE 2.8
Euclidean Distance of BAT-BOT for NorCal and SoCal Speakers



ship surfaces between the backing of BAT and the backing of BIT or BOT, though the Euclidean distance between BAT and BOT is relatively similar (between 0.7 and 1.65) across the population (see figure 2.8). This may suggest that the positions of BAT and BOT are tethered in acoustic space (see Kendall and Fridland 2017, 255), such that adequate distance is maintained between the two lowest vowels in the system despite shifting. It is indeed possible that this is one of the motivations for the raising of BOT, a finding that is consistent with evidence that BOT is raising in apparent time in the California Central Valley (D'onofrio et al. 2016). That we replicate this finding suggests this phenomenon may be more widespread across California.

Together, these findings suggest a structurally interrelated system consistent with chain shifting; a backed BAT implies both a low BET and a raised BOT. The speakers in our sample exhibit patterns very much in line with those of the LBMS, despite a number who fall short of complete Low Back Merger. We discuss the implications of this finding in the following section.

DISCUSSION

THE LOW BACK MERGER AND THE LMBS. Our results indicate that, at least for some speakers, it is possible to exhibit short front vowel rotation characteristic of the LBMS without exhibiting full low back overlap. The null result from the investigations of BOT-BOUGHT Pillai scores suggests that overlap in these categories in the strictest sense is not necessarily connected to BAT backing. Instead, and in keeping with the picture of the LBMS provided in the volume, the height of BOT is more closely tied to BAT backing. While the difference between low back overlap and the height of BOT might seem minimal, we argue they indicate different pieces of information about the relationship between the low back vowels. While Pillai scores are a measure of token-to-token similarity between vowel categories, BOT raising suggests motion away from a canonical low back position in the vowel space. Additional weight is lent to this position given the finding that the F2 of BAT is substantively connected to motion in F1 of the adjacent vowels in the LBMS, while low back overlap is not. Thus, complete Low Back Merger does not appear to be a necessary precursor to BAT backing. Instead, BOT movement toward BOUGHT is sufficient to motivate movement in BAT and subsequently, the rest of the short front vowel system.

Because this analysis posits a pull chain for the LBMS, some commentary is warranted given our earlier claim (Kennedy and Grama 2012) that the short front vowel rotation may have been the result of a push chain. Subjects in that study demonstrated wide variance in formant distribution for BAT and BOT—enough that a gender effect emerged in F2 for BAT, whereby women were more backed than men. Because there was no similar effect in BIT and BET, we inferred that their position was much more firmly established in our sample and that the variance in BAT suggested it was the last of the three categories to shift along the LBMS dimension.

While the gender effect was real, this inference was too strong. Nevertheless, the distribution of vowels in Kennedy and Grama (2012) was consistent with what we demonstrate here: more variance in low vowel space compared to the non–low front quadrant. Given the approach of the present study, we suggest that both samples support the same claim: that the low vowel space is variant enough that the LBMS can proceed independently of whether BOT and BOUGHT are fully merged and that it is the raising of BOT that is at the heart of the shift.

Thus, we affirm that our past and current research converges with other significant research on the topic (see Becker 2019 [this volume]) that portrays the LBMS as a pull chain, in which BIT and BET proceed in a less-scattered trajectory into space created convergently by a range of different low vowel reconfigurations. It is this diversity in low vowel configurations that we now turn to.

LOW VOWEL INSTABILITY AS A MOTIVATION FOR LOSS OF CONTRAST. Given our findings and those of the volume more broadly, we wonder not only why the movement toward suspension of contrast in the low back vowel space serves as the trigger for the LMBS but also why the low back vowels merge.

Stepping back from the specifics of California, Canada, and similar varieties with the LBMS and the Low Back Merger, it will help to consider additional comparative evidence to elucidate the nuances of the low vowel space. Importantly, variation in the low vowel space goes beyond the identification of merged and unmerged varieties; it is readily observable in varieties outside North America. Moreover, this discussion establishes that the merger has occurred at different points in time and that maintenance of low back contrast is variable enough to suggest a long history of instability.

First, low back overlap is not restricted to North America; varieties of Ireland and Scotland show evidence of overlap in the vowels of BOT and BOUGHT (Wells 1982; Stuart-Smith 1999, 2004; Ferragne and Pellegrino 2010). It may be that low back overlap has a long history in these regions of the British Isles. Second, the patterning of lexical incidence into distinct categories is itself variable within contrastive varieties. For example, Wells (1982) acknowledges the CLOTH set of tokens, which pattern with BOUGHT in the United States but with BOT in low back contrastive varieties of England including RP. Labov, Ash, and Boberg (2006) note similar behavior for *on* in the United States, which patterns with BOT in the North but with BOUGHT in the Midland, Mid-Atlantic, and South. Another aspect of this variance appears in the PALM lexical set, which patterns with BOT in the North America but not with other varieties more generally. In table 2.5, we give an overview of the variability in the low back vowel space across varieties. The different distributions of lexical incidence and contrast across this range of varieties suggests that the low back region of the vowel space was already unstable across Britain during colonial eras of transatlantic migration. In such a scenario, the classes of vowels defined here as BOT and BOUGHT would not have been clearly delineated, settling upon overlap in some varieties of Scotland and Ireland and upon two clusters of lexical items in other varieties. In the latter case, the fact that a substantial set of

TABLE 2.5
Low Back Contrasts across English Varieties

<table>
<tr><th></th><th>ANAE</th><th>Wells</th><th>England</th><th>Scotland/ Ireland</th><th>Contrastive U.S.</th><th>Overlapped North America</th></tr>
<tr><td>BAT</td><td>(æ)</td><td>TRAP</td><td>æ</td><td rowspan="2">a</td><td>æ</td><td>æ</td></tr>
<tr><td>BALM</td><td>(ah)</td><td>PALM</td><td>a</td><td rowspan="2">ɑ</td><td rowspan="4">ɑ ~ ɒ</td></tr>
<tr><td>BOT</td><td>(o)</td><td>LOT</td><td rowspan="2">ɒ</td><td rowspan="3">ɒ</td></tr>
<tr><td rowspan="2">BOUGHT</td><td rowspan="2">(oh)</td><td>CLOTH</td><td rowspan="2">ɔ</td></tr>
<tr><td>THOUGHT</td><td>ɔ</td></tr>
</table>

items (i.e., Wells's CLOTH set) patterns with BOT in England but BOUGHT in the U.S. adds to this picture of instability.

Returning to North America, it is conceivable that the overlap of the low back vowels may have a more nuanced origin than a simple plausible merger occurring at multiple points in time and space. The Low Back Merger could be construed partially as a natural result of a blurring of the BOT-BOUGHT boundary occurring in second waves of migration (e.g., Americans into Ontario or the West) and partially as a trait inherited from Scottish and Irish migrants. The timing of the appearance of the Low Back Merger is itself variant across North America. For Canadian English, there is evidence of overlap among some component of its founder populations (Scott 1939; Sprague de Camp 1939; Chambers 1993; Dollinger 2010), attributing the merger to migrant American Loyalists, a critical mass of Scottish immigrants, or perhaps both.[6] Thus, overlap has been in some parts of North America for centuries, and its existence in Canada is apparently far older than the short vowel shift. Other varieties of North American English range in their apparent history of the merger; McLarty, Kendall, and Farrington (2016) demonstrate its longer history in Oregon, while others show evidence that it is a relatively more recent phenomenon (Hall-Lew 2013; Podesva et al. 2015; Cardoso et al. 2016; D'Onofrio et al. 2016). Even within California the contrast is variable. It is maintained in some inland varieties and speakers in San Francisco (Hall-Lew 2009), while apparent-time analysis suggests it is relatively more recent in the coastal cities. Other dimensions of variation provide similar implications. For example, in our earlier study (Kennedy and Grama 2012), we detected more variation within the low vowel space, wherein men and women cluster together in their implementation of BIT and BET, but are more variant in BAT and BOT. This low back variation, even with a pool of ostensibly merged speakers, suggests a recent period of instability in this part of the vowel space.

We thus suggest that the low back vowel space may have always been unstable; that Scotland and Ireland may conserve a system that resisted the emergence of a distinct BOUGHT class; and that, because of the nature of transatlantic migration during the Revolutinary Era, some North American varieties may have inherited this trait. Conversely, other merged varieties like those of California and the American West appear to have innovated the Low Back Merger.

Questions surrounding the structural progression of the shift remain. There has been a much longer period of time separating low back overlap and the short-front shift in Canada than in merged American varieties. This difference is difficult to explain, but it does lead to a salient contribution for us here, which is that we continue to find more variance in low and low back space than we do in the higher regions of articulatory vowel space. Indeed, the merger is recent enough in California to suggest that evidence of the LBMS can appear in some speakers who nevertheless adhere to some lingering degree of low back contrast. While this may imply that the shift occurs irrespective of complete merger, our analysis nevertheless supports the idea of a link between the phenomena.

UNIFYING THE CANADIAN AND CALIFORNIAN VOWEL SHIFTS. We now turn to a central question in this volume, which concerns what these findings indicate about the relationship between the California and Canadian Vowel Shifts. Here we wish to echo Sadlier-Brown and Tamminga (2008, 12), who stress the role played by variation across regions in the LBMS:

> [T]he input condition of the low-back merger may not necessitate an identical development in different dialects despite triggering a shift in generally the same direction. Rather, there seems to be room for regional variation in the [Canadian Shift].

This observation appears to gel well with the way our speakers pattern. That our speakers show variance in their low vowels suggests that there is a range of low vowel configurations, many of which can precipitate motion in BET and BIT. This appears to be the case regardless of whether BOT and BOUGHT are fully overlapped. Instead, we find that speakers need only exhibit requisite motion in BOT, which allows for the backing of BAT and subsequently the rest of the short front vowels. Indeed, approximating the positions of BOT and BOUGHT, whether by the Lower Exit Principle (i.e., low nonperipheral vowels become peripheral [Labov 1994, 280]) or some other mechanism, is one solution to reorganizing a low vowel space that has always been highly variable. We therefore believe it is not surprising from a structural perspective that geographically distinct dialects could have developed similar shifts considering a system of low vowels characterized by a history of variability. Ultimately, this suggests that the two shifts—as well as their related instantiations that have swept across North America—are more properly treated as one shift, incited by largely identical structural pressures, regardless of regional differences in phonetic implementation.

We finally turn to the renaming of the shift as the Low-Back-Merger-Shift. With some caution, we believe this is a good choice, as the recurrent confluence of the Low Back Merger and relatively low, backed realizations of the short front vowels suggests a parallel triggering structural event. The name LBMS captures this relationship and does not imply a strong connection with region, important given the wide range of places that show evidence of the shift.[7] Indeed, a strict model of diffusion insufficiently explains the spread of the LMBS, and it is our prediction that any variety with a suspension of low back contrast would be subject to the LBMS.

However, our only caution regarding the term is in its embedding of "merger." As discussed in Becker (2019 [this volume]), it is the initiation of BOT's movement toward BOUGHT—not complete merger—that appears to trigger the LBMS. We have likewise argued here that complete Low Back Merger is not a prerequisite for the LBMS. It is therefore crucial that, despite its name, the low back distinction not be viewed as a barrier to the LBMS, only that movement of BOT allows for the possibility of the shift.

NOTES

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1. For vowel notation, we follow the practice of the other chapters in this volume in adopting a variant of Wells (1982) that uses a consistent B_T carrier environment.
2. In earlier versions of this work, we refer to the lack of low back contrast as "low-back identity" in order to cover varieties in which the previously distinct low back vowels have merged as well as those in which the contrast never existed in the first place. Instead, in keeping with the rest of the volume, we have adopted the term "Low Back Merger," since "identity" commits to a one-phoneme analysis, despite the granularity of the phenomena that we and others in this volume adopt in our analyses. Because of this granularity, we actually prefer "overlap" to "merger," which to us implies completion, and will thus use "overlap" in discussions of speakers for whom the merger is not quite complete.
3. Speakers identified with a range of ethnic backgrounds (Armenian, African American, East Asian, Latinx, South Asian, and white). There were not enough participants in each group to allow for balanced comparisons across ethnicity. However, impressionistic analyses suggest no major differences arise between ethnic groups in either the Low Back Merger or the LBMS for our sample.
4. While recordings averaged approximately one hour, some speakers took part in an abbreviated protocol, which yielded less conversational speech. Analyses of conversations were conducted only with speakers who took part in the full interview protocol.

5. Considering Bates (2006), we report *t*-values as well as *p*-values when reporting the output of linear regression models.
6. Variation between merger and overlap would have been a likely scenario at the time even in nascent Canadian English; Pringle and Padolsky (1983) note the persistence of low back contrast in former Loyalist communities along the St. Lawrence River in Eastern Ontario.
7. This is not meant to imply that aspects of the LBMS have no connection to region or place, as BAT backing shows a strong socioindexical link with California (see, e.g., D'Onofrio 2015; Villarreal 2018) even in areas where the shift is robustly present (Villarreal, Kohn, and Hattesohl 2018), only that the shift itself is widely geographically distributed.

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JAMES GRAMA is a postdoctoral fellow at the ARC Centre of Excellence for the Dynamics of Language at the Australian National University, where he works on the Sydney Speaks project. He holds a Ph.D. from the University of Hawai'i at Mānoa. His research focuses on sociophonetics, language variation and change, variation in creoles and underdocumented languages, and the optimization of computational methods for phonetic research. His work has appeared in *Linguistics Vanguard*, *Journal of the International Phonetic Association*, and *American Speech*. E-mail: james.grama@anu.edu.au.

ROBERT KENNEDY is a senior lecturer in linguistics at the University of California, Santa Barbara. His research has focused on the typology and analysis of segmental and rhythmic alternations in reduplicative phonology, with an emphasis on interactions among stress patterns, morphological structure, and allomorphic phenomena, as well as sociophonological variation within and across the vowel systems of varieties of English, especially with respect to formant dimensions and contrasts in varieties of California English. His work has appeared in *Linguistic Inquiry*, *Phonology*, and *American Speech*. He is also the author of *Phonology: A Coursebook* (Cambridge University Press, 2017), an introductory textbook for students of phonology. E-mail: rkennedy@linguistics.ucsb.edu.