University of Pennsylvania Working Papers in Linguistics

Volume 16
Issue 2 *Selected Papers from NWAV 38*

Article 13

1-1-2010

Mapping Production and Perception in Regional Vowel Shifts

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Abstract
Drawing from data from a multi-region US vowel production and perception study, we investigate the extent to which vowel production and perception are related for talkers from Memphis, Tennessee. Focusing on the mid-front vowels and the variable degree of Southern Vowel Shift (SVS) exhibited productively by thirteen individuals, the study investigates the role of individual variation in perception. We show both that individuals who participate more strongly in the SVS have more shifted perceptual systems and that perceptual shift can operate somewhat independently from productive shift. We further consider our data in terms of the proposal by Sumner and Samuel (2009) that dialects should be understood as having three components, production, perception, and representation, and not simply in terms of production.

Mapping Production and Perception in Regional Vowel Shifts

Tyler Kendall and Valerie Fridland*

1 Introduction

In recent decades, sociolinguistic aspects of vowel production have been studied in greater depth than sociolinguistic aspects of vowel perception. However, based on the patterned transmission of change across groups and time, it seems apparent that speakers' productive capabilities are based in part on the speech they perceive around them (beyond infancy). Still, speakers do not necessarily always sound like those they have the most contact with and children do not necessarily pick up or continue to use variants used by their parents. So while there clearly exists a link between perception and production, how this link is mediated and to what degree a speakers' own productive system mirrors and/or interacts with his/her perceptual system is less clear. As part of a larger project investigating the relationship between production and perception across U.S. regions, the current paper examines how individual variation in the production of vowel categories within a single region aligns with individual variation in perception of these same categories, asking what kinds of relations exist between speakers' actual speech production and perception. To do this, participants raised in Memphis, Tennessee, performed a vowel identification task and then subsequently were recorded reading a reading passage and word list containing a number of realizations of each vowel in different lexical contexts.

Memphis is an area where vowel production is affected by the Southern Vowel Shift (SVS), one of the main regionally-based vowel shift patterns found currently in the U.S. (cf. Feagin 1986, Fridland 2000, 2001, Labov 1994, 2001, Labov et al. 2006, Thomas 1989, 2001). In general, systems affected by the SVS show strong /e/ centralization and /ɛ/ peripheralization (and, less commonly, /i/ centralization and /ɪ/ peripheralization) which results in the acoustic reversal of these vowels. This shift in acoustic space in the South contrasts with shifts occurring elsewhere, namely in the North (Gordon 1997, 2002), where other shift processes appear to be making front vowels more divergent across dialects. While there is ample evidence that productive differences are found regionally and some evidence of perceptual awareness of these differences (e.g., Clopper and Pisoni 2004a, 2004b, 2007), our main interest in this paper is whether degree of shift participation in production within a region (and not just regional affiliation) also has consequences on the performance of a perceptual vowel categorization task. In other words, how much is productive individual variation reflected in perceptual individual variation, regardless of larger community norms? Further, following up on a recent suggestion by Sumner and Samuel (2009:500), we consider "what it means to *have* a dialect" and assess these vowel shifts not only as productive phenomena, but as perceptual phenomena as well.

As noted, while our overall project examines production and perception data from multiple regions of the U.S., the current paper focuses on the linguistic systems of individuals from Memphis examining the relationship between these individuals' productive participation in the SVS and their perceptions of synthesized vowels. For sake of space, we focus our discussion on the mid-front vowels, /e/ and /ɛ/. Fuller results of this study, considered from other perspectives, are presented elsewhere in Fridland and Kendall (submitted) and Kendall and Fridland (2010).

2 Sociolinguistically-Related Perception Research

Of the relatively few studies that have examined sociolinguistic aspects of perception, most have established that social differences influence the way listeners perceive stimuli of varying kinds (e.g., Clopper and Pisoni 2004a, 2007, Fridland 2008, Fridland et al. 2004, Graff et al. 1986, Janson 1986, Koops et al. 2008, Labov and Ash 1997, Niedzielski 1999, Plichta and Preston 2005, Preston 1989, Willis 1972, Purnell et al. 1999, Strand 1999). Such studies have established that

*This research was supported by a grant from the National Science Foundation Linguistics Program BCS#0518264. We would also like to thank Teresa Dalle for her help with data collection.

listeners are perceptually aware of community-based differences in speech production and that linguistic experience and resulting expectations (based on previous exposure to particular dialects/speakers) also affect perception. For the most part, however, these studies have looked only at general dialect background in perception, not listener-specific aspects of production.

A few studies have looked at the relationship between participants' selection of the best exemplar of a vowel and their production of that vowel (Johnson et al.1993, Frieda et al. 2000), generally concluding that best exemplars most closely resemble hyperarticulated production (the "hyperspace" effect). In addition, some studies have suggested that regionally and socially based variation in production influences how listeners interpret speech stimuli (Evans and Iverson 2004, 2007, Hay et al. 2006, Sumner and Samuel 2009). The results of these studies do suggest overall that dialect experience is important in perceptual processing and that a speaker's own production norms, not only broader community norms, play a role in how variable forms are perceived. However, while suggesting production and perception are related at some level, these studies have also shown that production is inconsistently related to perception, with social orientation and experience, among other factors, complicating the relationship.

3 Experiment and Data

3.1 Vowel Perception Study

The perception data of interest here were elicited from a vowel identification test that was developed using a traditional design in speech perception research. Vowel tokens from the same talker were randomly played for listeners who were then asked, in a forced-choice format, to indicate the token they just heard from a list of two choices (Hillenbrand et al. 1995, Strange 1995, Thomas 2002).

The current paper focuses on participants' categorization of steps along an /e/ to /ɛ/ continuum. The seven step vowel continuum was embedded into two different consonant contexts (preceding labial and preceding alveolar) resulting in a seven step continua from *bait* to *bet* and *date* to *debt*. Here, we focus our investigation on the /b/ context. The continuum range was synthesized based on a sample speaker's production values for each of the two selected endpoint vowel categories. The sample speaker was a 40-year-old male from Reno, Nevada, who was chosen with regard to unmarked dialectal features in line with Clopper and Pisoni (2004a). Thus, in synthesizing the /e/–/ɛ/ continua, the speaker's /e/ and /ɛ/ class values were used as endpoints. Based on these endpoints, the stimuli were created with vowel synthesis software by Bartek Plichta.[1] For the test, each trial presented a single vowel-continuum step (played once) and participants were asked to indicate the token they just heard from two choices drawn from the relevant vowel categories (e.g., *bait* or *bet*). Each step in each vowel continuum had four iterations, i.e., was played four times in random order, over the course of the study. In order to be simultaneously implemented across regions, the test was developed and administered through a website.

3.2 Speech Samples

In addition to participating in the vowel identification tasks, a subset of participants from each region were also recorded reading a reading passage and word list so that we would have production data to correlate with the perceptual findings. All speakers read the same reading passage and word list with the same instructions (to read the passage over before recitation and to pause briefly between each word recitation), so prosodic differences across speakers should be minimal. For the present paper, we focus on 13 participants from Memphis who contributed both speech data and perception data. As noted above, fuller data from several regions are addressed elsewhere.

4 Data and Analysis

[1]Available at http://bartus.org/akustyk/synthesis.html.

Figure 1 displays the overall perception results for the 13 Southerners of interest here. Again, each speaker judged four iterations of each step, so each continuum step increment in the plot of Figure 1 represents the percentage the step was heard as /ɛ/ across 52 listens (13 listeners x 4 tokens). As a group, the Southerners heard /e/ entirely for the first two continuum steps and then increasingly heard /ɛ/ through steps 3–7. By step 7 the Southerners heard almost entirely /ɛ/ (94.2%). The dashed lines in Figure 1 show one standard deviation from the group's mean, however, and viewed from this perspective we see that there is a range of perceptions among the Southern listeners. While perception data have been found to be "messy" and we would not expect to find exact agreement by all listeners and, further, would expect that a number of factors influence a listener's categorization of acoustic stimuli (e.g., prior exposure, residency, dialect experience, attention to the task; Clopper and Pisoni 2004a, 2004b, 2007, Dahan et al. 2008, Hay et al. 2006, Sumner and Samuel 2009), we may still ask: can we account for (some of) this variability by making recourse to the listeners' own vocalic productions?

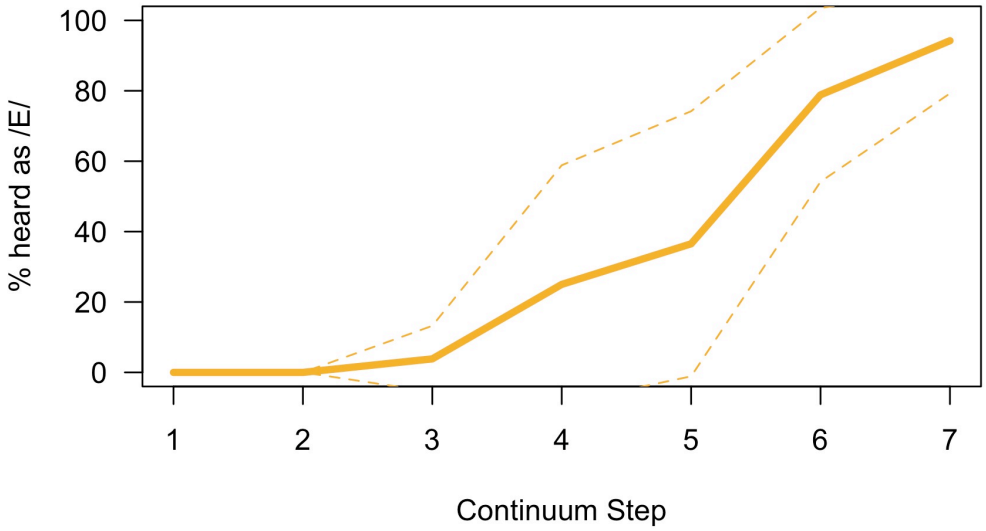

Figure 1: Perception results for /e/ to /ɛ/ for 13 Southerners.

Figure 2 displays the front vowels (/i/ in green, /ɪ/ in orange, /e/ in blue, /ɛ/ in red, and /æ/ in purple) for each of these 13 Southerners. We see here a wide range of variability in production among these speakers. Speakers like "Isaac815," "Laura816," and "nawill10," with high degrees of overlapping front vowels (in particular mid-front vowels), show massive participation in the SVS, especially in comparison to speakers like "Kim1111," "Matt2526," and "Roj1518," who show little to no participation in the front vowel components of the SVS. This range of productive variability suggests that lumped vowel comparisons across or within regions does not fully capture intradialectal variation that, crucially, may be indicative of individuals' orientation not only to what they produce, but also to what they perceive.

To investigate this further, we classify these speakers into two sub-groups, Southern "Shifters" versus "Non-Shifters", based on their front vowel productions. As noted earlier, a major feature of the Southern Vowel Shift is the acoustic reversal of the mid-front vowels, caused by the backing and lowering of /e/ (Fridland 2000, 2001, Labov et al. 2006). Figure 2 reinforces the view that the mid-front vowels are extremely variable for Southern speakers; it is for /e/ and /ɛ/ that we see the most striking range of variability among the speakers. For this reason, we base our subdivision of these speakers on the Euclidean distance between each speaker's /e/ class vowels and /ɛ/ class vowels.

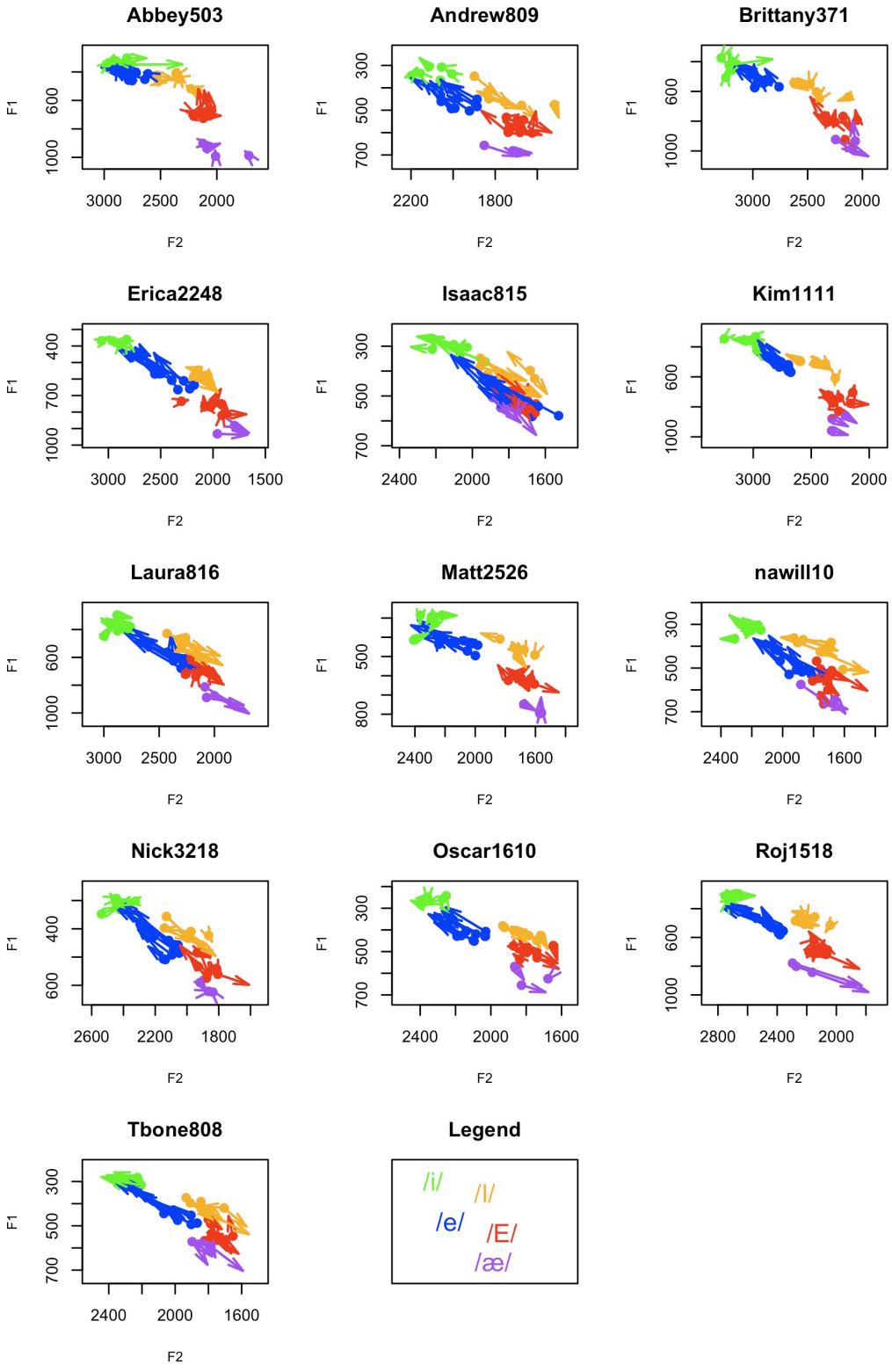

Figure 2: Front vowels for 13 southern speakers.

Figure 3 displays these distances, in Lobanov normalized units (Lobanov 1971, cf. Thomas and Kendall 2007) for both onsets (measured at 1/3 of each vowel's duration) and glides (measured at 2/3 of each vowel's duration). Isaac815, Laura816, and nawill10, with visibly overlapping distributions of /e/ and /ɛ/ (in Figure 2) and extremely small onset distances (seen in Figure 3), clearly fall into the "Shifters" group. Nick3218, although less clearly so in Figure 2, is also classified as a "Shifter" with /ɛ/ glides that are more proximate to /e/ than most other speakers. (Beginning with Figure 3, we indicate the "Shifters" with red and the "Non-Shifters" with purple.) Glide distances showed much less variation across speakers, though "Shifters" do tend to cluster on the left.[2]

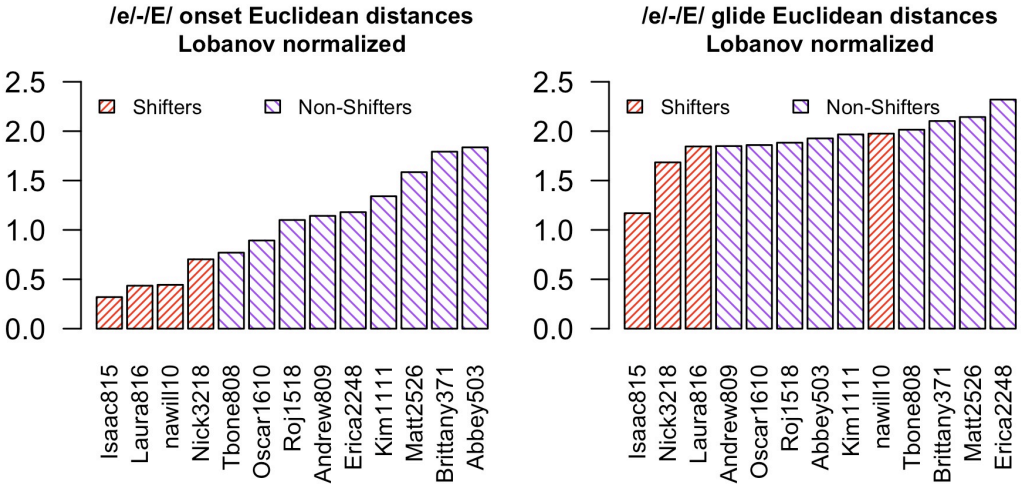

Figure 3: Euclidean distances between /e/ and /ɛ/ for the 13 subjects.

Figure 4 displays the perception results for each of the 13 Southerners individually, as well as a combined plot that displays the data as subdivided by the extent to which the individuals participate in the SVS, according to their front vowels (the plot at the upper-left). The dashed horizontal lines in the figure display the 50% mark on each plot, the crossover point at which each listener hears /ɛ/ rather than /e/ more than 50% of the time. As we might expect, both from the standard deviations in Figure 1 and from more general knowledge about variability in perception (Evans and Iverson 2004, 2007, Foulkes and Doughtry 2006, Frieda et al. 2000, Hay et al. 2006, Johnson 1997, 2006) there is quite a range of variability across individuals. However, with a few outliers, we can also notice a pattern here. The "Non-Shifters," e.g., "Brittany371," "Kim1111," and "Matt2526," tend to be characterized with (a) a more S-shaped perception curve, (b) an earlier transition from hearing primarily /e/ to primarily /ɛ/, and (c) a crossover point in the middle of the continuum. The Southern "Shifters" on the other hand are characterized by (a) an abrupt shift in perception from /e/ to /ɛ/, (b) a high proportion of the continuum heard almost entirely as /e/, and (c) a crossover point later in the continuum (> 5, or even as high as > 6 for "Isaac815"). As noted, there are exceptions of course; for instance, "Abbey503" and "Andrew809" have perceptions that are quite similar to the "Shifters" and "Nick3218," a "Shifter," has an S-shaped perception curve.

Despite the fact that there is some overlap in the perception results we find for a couple of "Shifters" and "Non-Shifters," a mixed-effects regression (e.g., Johnson 2009) treating listener as a random slope finds that this division of the Southerners into a "Shifters" group and a "Non-Shifters" group significantly differentiates the perception data. The regression results are given in Table 1. As is expected, each increment in the continuum step significantly increases ($p < 1E\text{-}9$)

[2]Glide distances likely relate to durational differences among these speakers' vowels. For sake of space, we leave this discussion to a later paper.

the likelihood of a token being heard as /ɛ/ (with a log-odds increase of 1.85 per step). If the listener is in the "Non-Shifter" group (a division based on his/her production of /e/ and /ɛ/), there is a significantly greater ($p < .05$) likelihood of that listener hearing all tokens as /ɛ/ (with additional log-odds of 1.75).

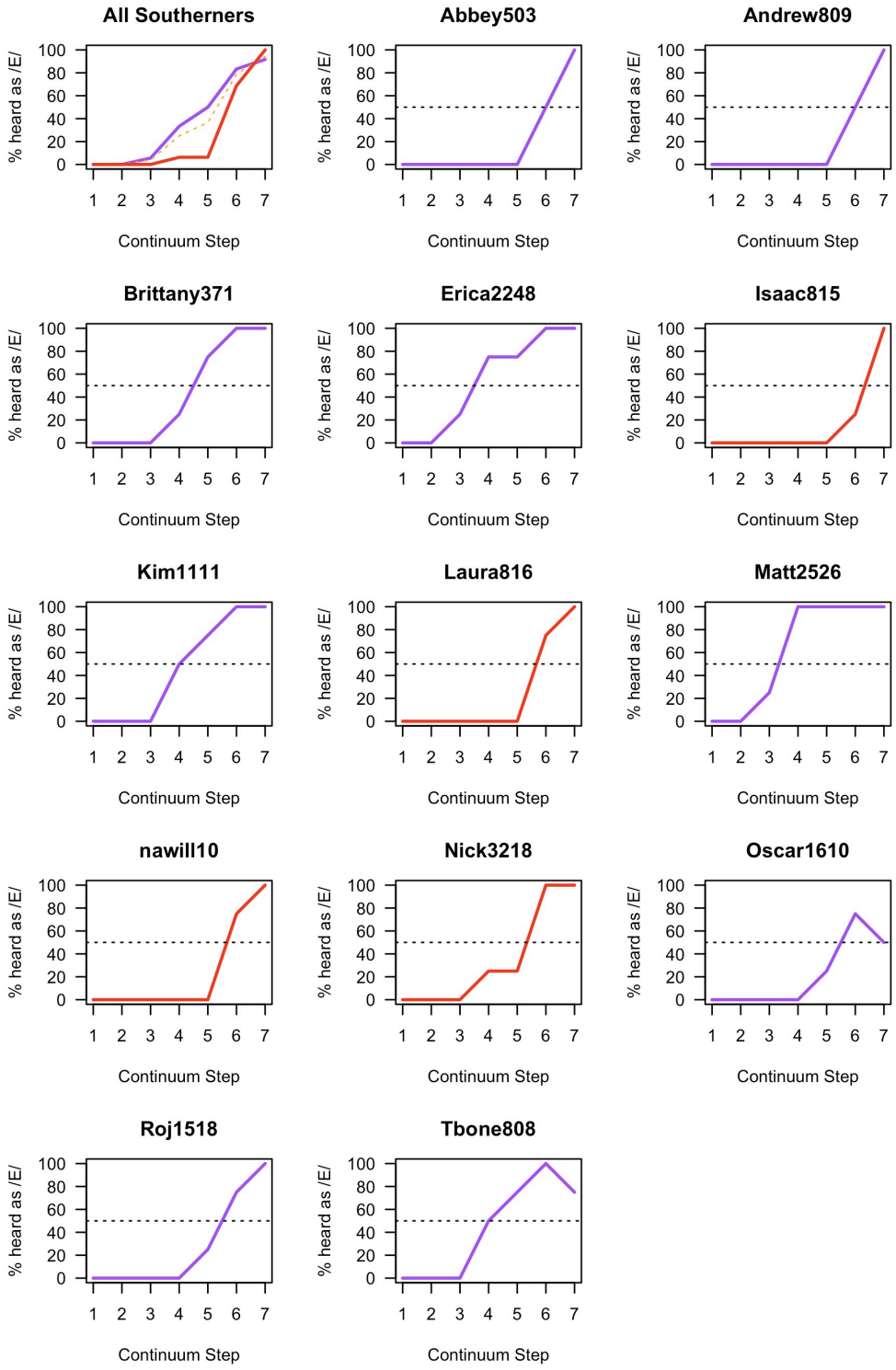

Figure 4: Perception results for /e/ (step 1) to /ɛ/ (step 7) for 13 subjects.

Random effects:					
Group	Name	Variance	Std. Dev.	Correlation	
Listener	(Intercept)	3.47715	1.86471		
	Continuum Step	0.66885	0.81783	0.926	
Fixed effects:					
	Estimate	Std. Error	*z*-score	*p*	
(Intercept)	–7.5887	1.1064	–6.859	6.93E-12	***
Continuum Step	1.8488	0.2952	6.264	3.76E-10	***
Non-Shifter	1.7532	0.8140	2.154	0.0312	*

Table 1: Results of mixed-effect logistic regression on hearing /ɛ/.

While models that attempt to use the actual (continuous) Euclidean distance measures as predictors do not obtain significance, these significant results (i.e., in the model in Table 1), based on our binary grouping of the speakers, do support the suggestion that perception and production are linked. Listeners in our sample with greater degrees of /e/ centralization in their own productions also appear to perceptually centralize /e/, classifying more central stimuli as /e/ compared with other (non-shifting) listeners.

5 Dialects as Productive and Perceptual Phenomena

As Sumner and Samuel (2009) discuss, the typical view of "dialect," both in popular conceptions of language and even within academic linguistics, is that a dialect is a configuration of productive features of a speaker's or group of speakers' language, but this view of dialect may be impoverished. In their study of (productively) /r/-ful and /r/-less New Yorkers, they find significant differences in perceptual processing between the two groups, despite both groups receiving similar daily exposures to the same /r/-less variants. Sumner and Samuel interpret their results as indicative of differences in the underlying representations of the forms for these speakers and suggest that dialects should be considered (or even defined) not only in terms of speakers' productions, but also in terms of their perceptions and representations. They further offer that these three "aspects of a dialect may differ within an individual, just as they differ between individuals" (Sumner and Samuel 2009:500). To explore this idea further, Figure 5 displays a scatter plot of the /e/ - /ɛ/ Euclidean distance measurements for the speakers against the 50% crossover points for their perceptual data. The speakers in the upper-left-hand portion of the plot (in red) are the four "Shifters". They have high crossover points (> step 5) and small distances between /e/ and /ɛ/. While they are not the only subjects who have high crossover points (e.g., "Abbey503" and "Andrew809") or the only subjects who have fairly small Euclidean distances (e.g., "Tbone808"), these four cluster together in the plot. However, instead of considering all of these subjects in categorical terms as "Shifters" or "Non-Shifters" based on their vowel productions, we could consider the x-axis of the plot as indicating a continuum of productive shift and the y-axis as indicating a continuum of perceptual shift. Individuals, as we see, can take part in the shift productively and perceptually (e.g., the "Shifters") or perceptually but less so productively (or even not at all; e.g., "Abbey503").

At the same time, our data do show a difference in perceptual processing between the speakers with the most SVS shift productively and those with the least. There is enough individual variability to prevent our discovering a direct (linear) relationship between these production and perception data (recall our statistical models do not yield significance when investigating direct numerical relationships in the data). However, we do see some indication of a relationship between the production and perception data in Figure 5 (without "Abbey503" and "Andrew809," Pearson's $r = –0.85$, $p < .01$; with "Abbey503" and "Andrew809" the correlation is non-significant). That is, production and perception do appear to be linked at some level, even if this relationship is quite complicated and may not hold in linear terms for all individuals.

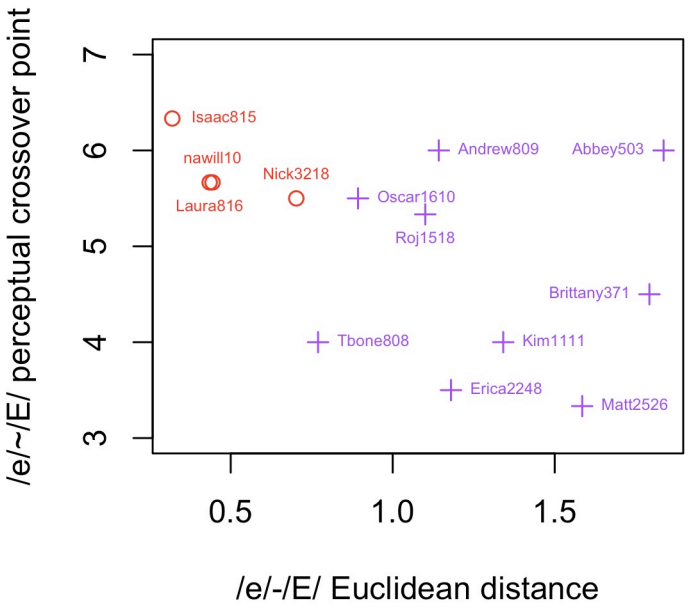

Figure 5: Euclidean distance versus perceptual crossover points for each speaker.

At first glance, this may seem contradictory to our plot in Figure 5 showing some "Non-Shifters" participating, more or less, in perceptual shift. However, such results are actually very similar to the "fluent listening" ability found by Sumner and Samuel in their NYC study, which suggested that perception is altered both by individuals' own variant use *and* by the language use found in the community (but not found in their own usage). On the surface, perception by users and non-users familiar with such variants seemed similar, but Sumner and Samuel found key differences between them in terms of their underlying representations. In other words, users had the variant as a stored representation, while non-users (though familiar with its use) did not. The "Shifters" here appear to show altered (productive and) perceptual behavior that may reveal altered category recognition, while "Non-Shifters" show various degrees of perceptual recognition of the range of variants within their community, but may not have the underlyingly shifted variant themselves. While our data are not able to speak directly to the question of possible differences in these individuals' underlying representations, we hope further study will fruitfully speak to this issue.

The participants in our study not only grew up in the same community, but in fact many of them were siblings. It seems unlikely and inaccurate that we should assume their differences in production and perception were due to distinct linguistic experience. Instead, it seems, exposure to variable norms within a single community creates the opportunity for similarly variable perceptual mapping, much like variable phonetic forms such as /p/ and /p^h/ give rise to differences across languages in terms of phonological mapping. Such contrastive/non-contrastive distinctions are socially acquired, through contact with speakers of the source language. Children with bilingual exposure can adaptively learn two different phonological systems, though without social motivation (such as peer group norms) the acquisition of another system may be weak, pointing to a pivotal role for social identity in the formation of our perceptual system. Perhaps it should not be surprising that speakers within a single community (or family) can form similarly adjusted representations, depending on the forms that are most constitutive of their individual social engagement.

Importantly, our results suggest that talker-listeners have exposure to (and make) variable productions, which are both socially and linguistically indexed. From this representational and perceptual range, some variants will become more salient than others as prototypical examples of a form. However, individuals can vary in where and how this salience is established, based on the formation of their individual identities. Thus, making assumptions about what constitutes a particular person's dialect on the basis of the productive norms of others in his/her community may

inaccurately represent this individual's own internal organization of this dialect experience, an experience which is established based not only on what he/she produces, but, crucially, also what he/she perceives. Thus, it seems evident that perception norms should be evaluated along with production norms when discussing the formation of a dialect, as the relationship between the two is not as straightforward or unidirectional as often presented.

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