

Network Characteristics of American Raising

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1 American Raising and the Network Characteristics of Early Adopters

The raising of the nucleus of /aɪ/ before voiceless consonants, as in *write* but not *ride*, has been observed in many North American English varieties (Davis et al. 2019, Fruehwald 2016, Joos 1942, Strelluf 2018). Its emergence appears to be phonetically motivated in some cases rather than the result of diffusion between communities (Chambers 1989, Thomas and Moreton 2008). Recent evidence from geographically diverse communities within the U.S. suggests that /aɪ/ raising is a new supra-regional sound change (Davis et al. 2019; Strelluf 2018; Davis and Berkson 2019). In comparison, the widespread merger of the low back vowels /ɑ/ and /ɔ/ appears to have begun at least two generations earlier (Fridland and Kendall 2017). We follow Davis and Berkson (2019) in calling /aɪ/ raising before voiceless consonants *American Raising*.

The widespread and recent emergence of American Raising offers the opportunity to study the social network characteristics of early adopters. Previous sociolinguistic network research has found evidence that early adopters of linguistic innovations or out-group linguistic variants have large or diverse first-order networks (Bortoni-Ricardo 1985, Labov 2001, Lippi-Green 1989, Rosen and Skriver 2015, Sharma 2017) or many weak ties (Labov 2001, Milroy 1980). Early adopters may also be “brokers” who serve as bridges between social groups (Cheshire et al. 2008), and they may have central positions in local networks (Eckert 2000). In Raleigh, a speaker's network position, in interaction with occupation and gender, correlates with the retention or loss of the traditional Southern vowel system (Dodsworth and Benton 2017, 2020). It is also assumed that urban speakers adopt linguistic innovations first; sound changes thus progress through hierarchical diffusion, reaching more rural areas later (Bailey et al. 1994, Labov 2003, Trudgill 1983).

While these studies offer insight concerning the network and other social characteristics of early adopters of linguistic changes, in general we do not know how consistent these traits are across different types of linguistic changes. Some evidence indicates that the leaders of one ongoing linguistic change in a community are not the same as the leaders of other linguistic changes in the community, except in the case of socially salient linguistic variables (Tamminga 2019). In communities where American Raising is very new, it is probably not yet especially salient, and its geographic diversity means that it lacks strong regional association. American Raising thus provides the opportunity to ask what characterizes the early adopters of sound changes, and in what ways the characteristics of the early adopters vary across communities.

2 Data and methods

This analysis compares the social distributions of American raising in two different social settings. The first is Raleigh, North Carolina, an urban setting in the Southeast, and the second is small-town Kansas as represented by suburban communities and rural agricultural communities located in the Great Plains region of the US. These settings differ not only in their population density, but also in demographic and linguistic trends. For several decades, Raleigh has been losing its Southern vowel system, including monophthongal /aɪ/ in voiced and free contexts (PRIZE and HIGH) (Dodsworth and Benton 2017, 2020; Dodsworth and Kohn 2012). These changes have been substantially driven by in-migration from other areas of the United States, stemming in large part from the growth of Raleigh's technology industry beginning in the 1960s.

In contrast, the Kansas communities have experienced either stable populations or population loss. The Kansas Speaks Project has investigated linguistic variation in four communities, three of which are included in the current analysis. These communities include a rural farming community (pop. 207) located in a county with a total population under 7,000, a bedroom community for a manufacturing town (pop. 896) in a county with a total population under 34,000, and a manufacturing and agricultural industry town (pop. 6,844) in a county with a population under 20,000. Despite the predominantly rural and agricultural setting in Kansas, vowel systems in the region share much in common with nearby urban hubs like Kansas City as documented by Strelluf

(2018) and Lusk (1976), and they appear to be participating in many supra-regional sound changes documented throughout North America (Becker 2020; Fridland et al. 2017). The front lax vowel system has been retracting since at least the Baby Boomer generation and the low back vowel merger is widespread (Kohn and Stithem 2015; Villarreal and Kohn 2020).

Both the Raleigh corpus and the Kansas Speaks corpus consist of conversational interviews that were transcribed and force-aligned using the Penn Phonetics Lab Forced Aligner (Yuan and Liberman 2008) following procedures described in Dodsworth and Benton (2020). The first three formants were automatically extracted at 25%, 50%, and 75% of the vowel duration. Only measurements for stressed vowels at least 60 ms in duration were retained. Each of the two projects uses a modified version of Lobanov normalization, although the Raleigh project used six phonemes as anchor vowels while the Kansas Speaks Project used three anchor vowels. As such, the normalized values reported here are not directly comparable across locations, but within-corpus speaker comparisons can be made. In total, 189 speakers from the Raleigh corpus and 38 speakers from the Kansas corpus are considered here. We focus on the formant measurements extracted at 25% of the vowel duration as an approximation of the vowel nucleus, but it is also useful to see the nucleus in the context of the glide (75%) measurements.

3 Apparent time change for /aɪ/ in Raleigh

In Raleigh, both the /aɪ/ nucleus and /aɪ/ glide have shifted across apparent time (Figure 1). Among speakers born before 1950, the glide (dotted lines) is more peripheral, higher and fronter, when the following sound is voiceless, as in *sight* or *bike*. When the following sound is voiced, as in *side*, or when /aɪ/ is the last sound in the syllable or word, as in *high*, the glide is much closer to the nucleus. In addition, for these older speakers, the nucleus (solid lines) is lower and backer in voiceless contexts such as *bike* than in voiced contexts such as *side*. The relatively high, front glide and low, back nucleus in voiceless contexts means that /aɪ/ is strongly diphthongal, while it is nearly or fully monophthongal in voiced contexts. Monophthongal /aɪ/ in voiced and free contexts is a distinguishing and salient feature of Southeastern U.S. dialects (Labov et al. 2006). The loss of this iconic Southern feature begins among speakers born around 1950, who grew up during the growth of Raleigh's technology and research sectors, and continues among the youngest speakers. The voiced and free glides become more peripheral among younger speakers, especially among women, with the result that /aɪ/ is variably diphthongal in all environments.

Figure 1 also shows that the /aɪ/ nucleus in voiceless contexts (solid light blue line) becomes higher and fronter after 1950 and ultimately becomes more peripheral than the nucleus in voiced contexts, especially among women. This movement suggests a pattern of American Raising similar to that found in other communities (Section 1), in addition to the loss of Southern monophthongal /aɪ/. Comparing the /aɪ/ nucleus between a younger speaker and an older speaker (Figure 2) highlights their different allophonic patterns. The speaker born in 1939 has a backer and more tightly clustered voiceless nucleus in comparison with his voiced and free contexts. The speaker born in 1991 has similar distributions across the three contexts with respect to both position and range, but her voiceless nucleus reaches higher and fronter than her voiced nucleus.

The fact that both changes, the loss of Southern monophthongal /aɪ/ and American Raising of the voiceless /aɪ/ nucleus, follow approximately the same timecourse in Raleigh gives us the opportunity to compare any network effects in their emergence. Because the lengthening of the /aɪ/ glide represents the loss of a regional dialect, but /aɪ/ nucleus raising is ongoing in many U.S. regions, we may find different network characteristics and leaders for the two variables.

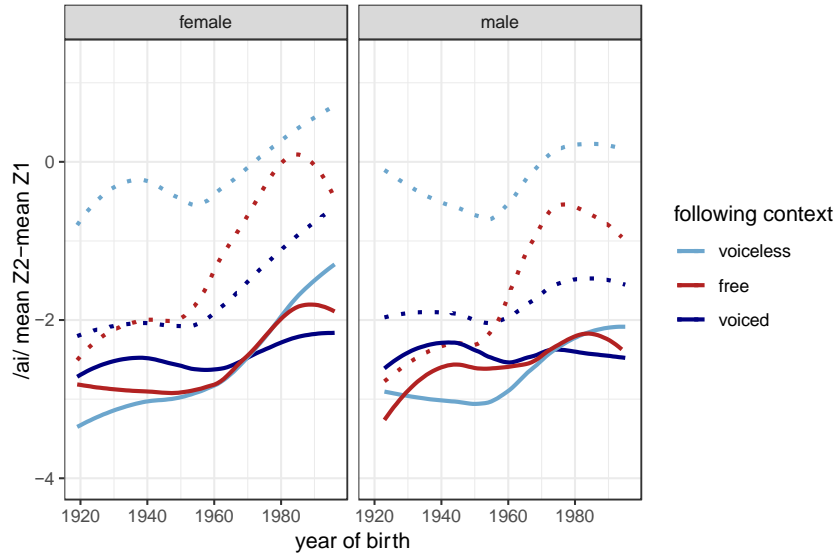


Figure 1. Lobanov-normalized Z2-Z1 for /aɪ/ by year of birth in Raleigh. The dotted lines are glide measurements (75% of vowel duration) and the solid lines are nucleus measurements (25% of vowel duration).

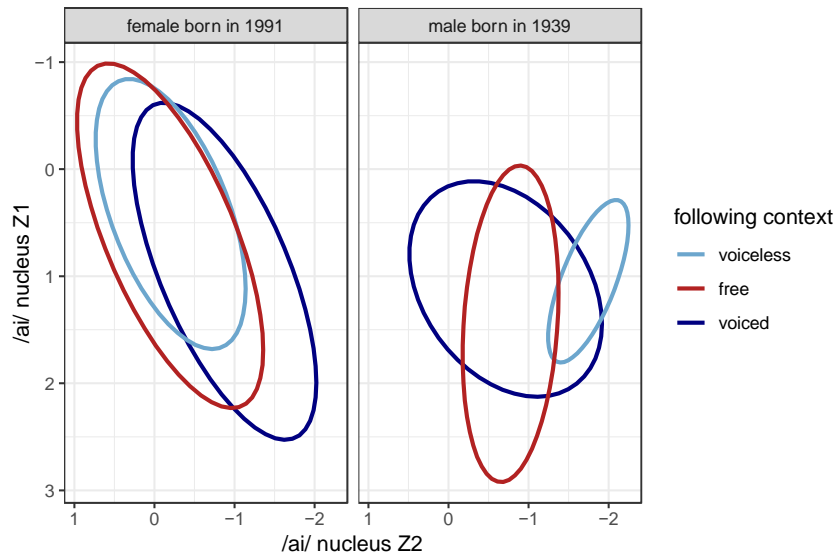


Figure 2. Lobanov-normalized Z1 and Z2 at the /aɪ/ nucleus for two Raleigh speakers.

4 Using Multiple Network Approaches in Raleigh

4.1 Clustering

We first examine network-based differences at a community level, using a community detection routine to find clusters of speakers in the community network. We summarize this approach here, but we refer the reader to Dodsworth and Benton (2020, Chapters 3 and 5), for a fuller explanation of the Raleigh bipartite network data, the community detection approach, and the quantitative analysis. Community detection routines have been used in sociology and related fields to identify subgroups within community networks. We apply community detection to the Raleigh network in

an effort to capture distinct social groups that emerge from speakers' co-attendance at Raleigh schools. These groups experienced uneven exposure to non-Southern dialects because non-Southerners moving to Raleigh for technology- (and other) sector jobs disproportionately joined certain schools and regions, especially North Raleigh (Figure 3). A community detection approach allows us to differentiate areas of the Raleigh network that were relatively isolated from dialect contact from those that experienced greater contact with non-Southern vowel systems. In the Raleigh data, network communities were identified using the QuanBiMo algorithm (Dorman and Strauss 2014), which is designed for bipartite networks.

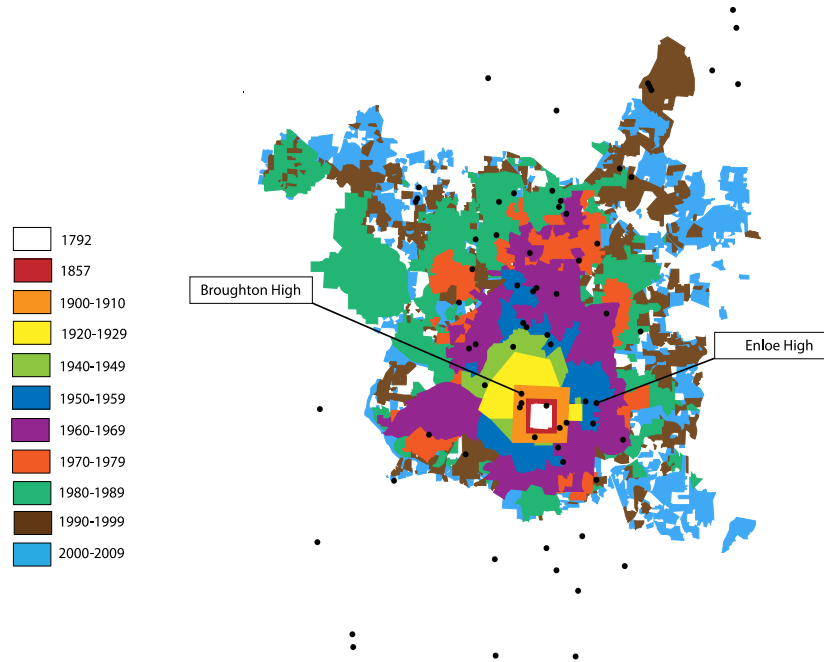


Figure 3. The growth of Raleigh's city limits by decade. Schools attended by speakers in the Raleigh corpus appear as black circles. Broughton High School (in an affluent central neighborhood) and Enloe High School (in an area known locally as East Raleigh) are two of Raleigh's oldest public high schools. City growth occurred predominantly to the North.

We evaluate the effect of network position (group membership as determined by the QuanBiMo routine) in two different generations, representative of different social eras in Raleigh's urban growth and linguistic change. Generation 2 (1950-1966) speakers were born just before the growth of Raleigh's technology industry, while Generation 3 (1967-1996) speakers were born during the continued population growth and urbanization. In a previous analysis (Dodsworth and Benton 2020, Chapter 5), a network module (subgroup) in Generation 2 corresponding to the affluent Broughton High School area (Figure 3) was found to be the least Southern module for two elements of the Southern Vowel Shift, the high front vowels /i/ and /ɪ/; this central module was less Southern than even the North Raleigh modules. However, within Generation 2, there is no main effect of network on the /aɪ/ glide, meaning that the distribution of Southern monophthongal /aɪ/ in this community is not a function of network structure as determined by the community detection routine. In contrast, among the next cohort of speakers, Generation 3, significant network module effects did emerge for the /aɪ/ glide: speakers in a North Raleigh module produced a *less* Southern, more peripheral /aɪ/ glide than speakers in other modules, and speakers in a Southwest Raleigh module produced a *more* Southern /aɪ/ glide. This is consistent with our hypothesis that North Raleigh speakers would lead the retreat from the SVS, relative to South Raleigh speakers, with respect to the salient feature of monophthongal /aɪ/.

We now ask whether the same network effects emerge for American Raising, the raising and fronting of the /aɪ/ nucleus in voiceless contexts. Network and other effects were evaluated via three

mixed effects regression models (Table 1) for Generations 2 and 3 separately. In each model, the dependent variable was Z2-Z1 at the vowel nucleus. **Model 1** had the fixed effects of preceding phonetic context, log duration, year of birth, occupation, and sex. **Model 2** added the fixed effect of network module, represented as a factor with 6 levels in Generation 2 and 8 levels in Generation 3. **Model 3** added the interaction between year of birth and network module. All models included random intercepts for speakers and words. ANOVA was used for model comparison. In Generation 2, Model 2 was significantly better than Model 1 ($p < .05$), indicating that the addition of the network module term improved the model fit. In Generation 3, however, neither Model 2 nor Model 3 was a better fit than Model 1 (Table 1).

Generation	N	Best model	Significant fixed effects in best model
Generation 2 (1950-1966)	77 speakers, 1387 tokens	Model 2 (with network modules but no interaction with year of birth)	<ul style="list-style-type: none"> ○ preceding phonetic context ○ duration ○ network module (Broughton area vs. a near-North Raleigh module in the northward dark blue and purple areas in Figure 1)
Generation 3 (1967-1996)	60 speakers, 1118 tokens	Model 1 (without network modules)	<ul style="list-style-type: none"> ○ preceding phonetic context ○ duration ○ year of birth (younger = more advanced raising) ○ sex (female = more advanced raising)

Table 1: Summary of mixed effects regression results for Generations 2 and 3. The dependent variable is Z2-Z1 at the PRICE nucleus.

In Generation 2, the module corresponding to the Broughton area (Figure 3) shows more advanced American Raising than a module corresponding to a North Raleigh area that was built during the early period of migration to Raleigh. That is, among the cohort of Raleigh speakers who first show evidence of American Raising, speakers who went to school in North Raleigh do not, contrary to our expectations, lead American Raising. There are also no significant effects of occupation or sex. The absence of a significant year of birth effect within Generation 2 may be due to the fact that this generation spans only 16 years. In Generation 3, however, younger speakers have significantly more advanced American Raising than older speakers, and females lead males. There are no significant network effects in Generation 3. We conclude that American Raising does *not* show the same network distribution as the iconic Southern feature of /aɪ/ ungliding, though it does resemble the high front vowels in Generation 2 insofar as it is led by the central Broughton module.

4.2 Individual-Level Analysis

Shifting from an aggregate to an individual-level perspective allows us both to explore the characteristics of the early leaders of American Raising and to look more closely at the contrast between the Broughton module and the near-North Raleigh module in Generation 2. Figure 4 shows mean PRICE Z2-Z1 for the individual speakers in these two modules. While we do not have consistent ego network data from individuals in the Raleigh corpus, we do tend to know whether they were “brokers” with ties to different social groups as children and adolescents, and whether they likely had consistently diverse linguistic exposure early in life.

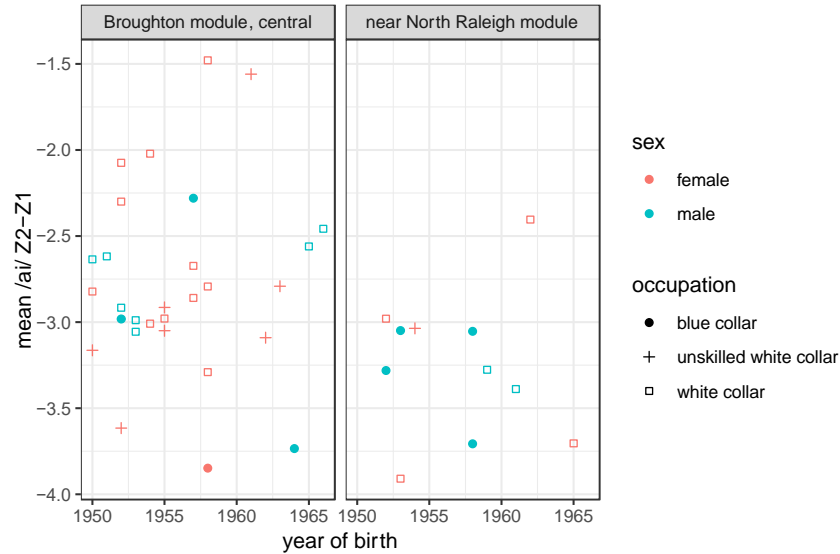


Figure 4. Mean PRICE Z2-Z1 for individual speakers in two Generation 2 modules. In the regression analysis (Table 1), the Broughton module (left) is found to significantly lead the near-North Raleigh module (right) in American Raising.

In both modules (Figure 4), several speakers have conservative (low, back) PRICE nuclei below -3 . In the Broughton module, however, more than half of the speakers have higher values, and the two overall leaders are in this module. Both of the two leading speakers are females, one white collar and one classified as "unskilled white collar", meaning that her job (secretary, in this case) does not require a college degree. The white collar speaker, born in 1958, is a broker in the sense that her parents are from New York, where /aI/ raising is more widespread (Vance 1987), and she has moved around the greater Raleigh area multiple times as an adult. For example, she grew up in central Raleigh but moved to Chapel Hill to attend college at the University of North Carolina, and she currently lives in Durham. The second speaker, born in 1961, has lived in Raleigh all her life and her parents are from smaller North Carolina towns. Our only explanation for her advanced American Raising is that she had two teenage daughters at the time of the interview, which might have exposed her to advanced variants. In the North Raleigh module, the single leading speaker grew up in Raleigh but moved out of state temporarily to obtain a graduate degree. Her mother is from New York and her father worked in academia, and she has teenage children. We conclude that she has had diverse linguistic exposure throughout her life.

The two women who produce the *least* advanced American Raising in this module both have blue collar parents and did not attend college, which likely means that their networks are more local or regional than others in the module. However, one of these two women, the blue-collar speaker, could be considered a broker insofar as she moved around Raleigh a great deal and held several different kinds of jobs. The most conservative speaker in the North Raleigh module attended Raleigh schools all her life but grew up in a peripheral, near-rural area where she probably had greater exposure to conservative Southern variants. However, we have no explanation for the other very conservative speaker in the North Raleigh module; she grew up in the middle of Raleigh and works in corporate law. In addition, the leaders in these clusters are not the only speakers with diverse linguistic exposure during childhood, nor are they the only speakers who had teenage or younger children at the time of the interview. While we can find explanations for some speakers' behavior as leaders or laggards in change, the individual-level examination does not lead to a consistent story. We suspect that at this early stage of American Raising, the intersecting effects of linguistic exposure, class identity, gender identity, and other factors influenced individual speakers in different ways.

Even when examining the full corpus rather than just two of the Generation 2 modules, the same inconsistencies appear. Younger speakers at the leading edge of the change have variable characteristics—some attended magnet schools, some moved between schools, some attended

schools near the center of Raleigh all their lives. Conversely, some of the least advanced speakers in the younger generation have been mobile within Raleigh and have geographically diverse ties. Comparable ego network data across speakers in both generations would be needed for confident individual-level conclusions.

5 Style

Another way to look at the leaders of change is to take a stylistic approach, focusing on intraspeaker differences to elucidate the social meanings of the incoming variable. Figure 5 shows the differences in position of the /aɪ/ nucleus between three stylistic settings for a female Raleigh speaker born in 1993 (Forrest 2018). The “interview” context is a standard sociolinguistic interview, the “casual” data were recorded while the speaker rode in the car with a friend, and the “work” setting was recorded while she was working as a cashier in a tech company cafeteria.

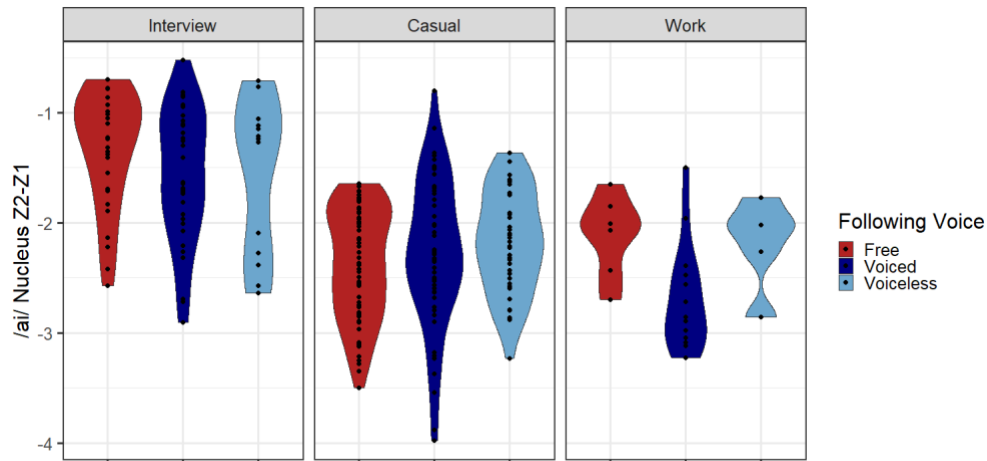


Figure 5: /aɪ/ nucleus Z2-Z1 for a female Raleigh speaker born in 1991 across three stylistic contexts.

In the cultural context of the company, the speaker has a job where sounding Southern is useful, but her /aɪ/ nucleus shows no trace of this in the interview setting; it is raised in all three phonetic environments. In a larger corpus of stylistic data (Forrest 2018), only the youngest speakers raise /aɪ/, and only in interview settings, following the pattern seen in Figure 5. The appearance of /aɪ/-raising only in the interview setting suggests that the raised variant has a non-Southern indexical meaning for these speakers, and that it is a socially desirable variant for formal settings. The young speakers' stylistic variation suggests that diversity of social contexts motivates linguistic diversity (Sharma 2017). Rather than a diverse first-order network corresponding to early adoption, a diverse network may instead correspond to greater *variability* in /aɪ/ nucleus raising (Sharma 2017).

6 Kansas Findings

The nucleus of /aɪ/ is also raising and fronting in the Great Plains, both in major cities (Strelluf 2018) and in more rural communities. Strelluf's (2018) study indicates that speakers born after 1990 consistently participate in American Raising in Kansas City, a sound change which appears markedly later than the low back vowel merger in this urban hub. Previous work indicates that smaller and more remote communities in Kansas do not necessarily lag far behind Kansas City in the adoption of supra-regional changes like the low back merger (Kohn and Stithem 2015; Villarreal and Kohn 2019). American Raising begins in rural Kansas at about the same time as in Kansas City (Figure 6). Women lead the change, as in Raleigh.

Apparent time and other effects were evaluated via mixed effects regression models, with Z2-Z1 at the vowel nucleus as the dependent variable. Base models with preceding segment and

duration were compared to increasingly complex models including year of birth, sex, and community, as well as an interaction between sex and year of birth, using ANOVA for model comparison. Thirty-eight speakers and 739 tokens were considered in this analysis. Similar to the Raleigh results, the best model included significant effects of year of birth, sex (female lead), community, duration, and preceding segment. Strikingly, the most remote rural community was not the most linguistically conservative. Instead, the bedroom community outside of a manufacturing hub was least advanced (Estimate: -2.51 vs. -1.96). Thus, the hierarchical diffusion model appears not to be consistent with the trajectory of American Raising in Kansas.

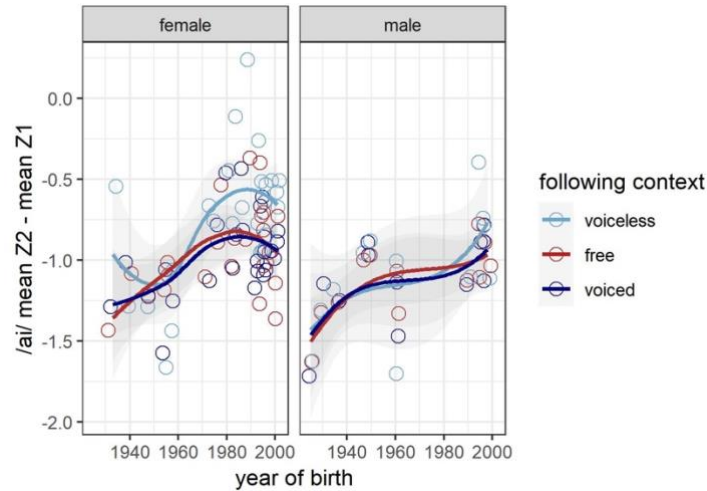


Figure 6. Lobanov-normalized nucleus (25%) Z2-Z1 for /aɪ/ for 38 individuals from three communities in Kansas

We can also consider mobility and network ties for individuals in the Kansas corpus. The female with the largest allophonic split (the most advanced American Raising) interned in California and travels frequently to Kansas City for shopping, baseball, and social events. The second lead female is an English teacher who traveled around the state of Kansas on sports teams in high school. The male leader travels also travels to Kansas City and Colorado for baseball games, vacation, and high school sports. While all of these characteristics would point to mobility as a factor for adoption and innovation, these leaders are not unique in attending Royals games, shopping in Kansas City, or participating in high school sports, activities that are rather pervasive across the entire population. A look at the most conservative speakers suggests that mobility does not guarantee adoption of American Raising. The most conservative female was born and raised on a farm, married a farmer, and rarely goes on vacations, but she did travel for high school sports and she continues to shop in urban hubs. The most conservative male never went to college and has mostly lived in his community, but he was in the Navy for three years, which suggests that he was exposed to a range of innovative linguistic features. The second most conservative male is the only conservative speaker who never travels, is not involved in sports that would encourage travel, and has a restricted social network. We conclude that in the context of small-town Kansas, travel patterns and social networks are suggestive but not conclusive with respect to early adoption of American Raising.

7 Conclusions: What Do We Know about the Network Characteristics Associated with American Raising?

Three main observations emerge from this analysis. In Raleigh, network position is a good predictor of the loss of Southern vocalic features, but not of American raising. In rural Kansas, /aɪ/ raising starts at about the same time as in Kansas City (Strelluf 2018), with no observed rural lag in the adoption of the new variant. In both Raleigh and Kansas, some of the leaders have expansive first-

order networks with weak ties, but so do some of the most conservative speakers. We still do not know the network factors facilitating the adoption and spread of supra-regional linguistic innovations like American Raising.

One possible way forward for sociolinguistic network research on the spread of supra-regional changes would be to draw inferences from studies of the network structure of cities. Within network studies, physical proximity remains important (Mok, Wellman, and Carrasco 2010), but the factors affecting the proximity of individuals have shifted dramatically in recent decades. Expanding income inequality has led to increased intra-city spatial segregation along economic lines, reinforcing the disconnect between individuals of different social classes (Dwyer 2010, 2012). At the same time, the interdependence between rural and urban areas has increased contact between individuals we may traditionally think are disconnected (Lichter and Brown 2011). Small, rural communities may not be so isolated, but population contact grows increasingly uneven across economic groups. These countervailing forces motivate sampling choices informed by factors like segregation and homophily to better isolate the network factors that facilitate pan-regional linguistic innovations.

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