Bipartite network structures and individual differences in sound change
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This paper assesses the influence of social network structure, and ultimately the role of the individual, in shaping the social trajectory of a set of vowel shifts in the Southern U.S. city of Raleigh, North Carolina. For more than 50 years, migration from other U.S. regions to Southern urban areas has promoted the ongoing shift away from the regional vowel system toward a regionally unmarked system. The nuclei of the front tense vowels /i/ and /e/ are becoming higher and fronter, and the nuclei of the front lax vowels /ɛ/, /ɪ/, and /æ/ are becoming lower and backer. Monophthongal /aɪ/ is giving way to diphthongal variants. The current sample consists of conversational interviews with 185 speakers who grew up in Raleigh.

Previous network studies in sociolinguistics have focused on individual-level network characteristics, such as integration in a dense local network (Milroy 1980, Lippi-Green 1989) or contact with others in different neighborhoods or from different ethnic groups (Ash & Myhill 1986, Cheshire et al. 2008, Labov 2001). Accordingly, these studies analyze individual linguistic behavior as a function of social identity and day-to-day social experience. By contrast, the Raleigh study focuses on *individuals' positions in the overall community network structure*. Raleigh's network structure is represented via a *two-mode* or *bipartite* network. Bipartite networks have two distinct classes of nodes: in this case, one class of nodes represents people, and the other class represents schools they attended. Ties occur only between people and schools. Bipartite networks indicate social proximity between people via their shared participation in an event or membership in an organization, even if those people do not come into direct contact (Davis, Gardner & Gardner 1941, Latapy, Magnien & Del Vecchio 2008, Opsahl 2013). Bipartite networks are especially useful in characterizing speakers' network positions in large urban settings, as opposed to the smaller, dense networks of many foundational sociolinguistic network studies.

Previous work concludes that position in the Raleigh bipartite network predicts linguistic production in the aggregate, particularly when the network data are bracketed by age and occupation (Dodsworth 2014, forthcoming; Dodsworth & Benton forthcoming). The current paper considers the role of the individual in advancing or resisting linguistic change in the context of network structure as well as the intersecting factors of class, age, and gender. The influence of network, and what this influence can reveal about individuals' participation in sound change, is determined by two separate approaches that offer different views of network structure.

The first network approach is *community detection* with QuaBiMo (Dormann & Strauss 2014), a hierarchical random graph algorithm for cluster identification in bipartite network data. The network clusters in the Raleigh corpus show distinct linguistic behavior; in particular, speakers who attended private schools and speakers from one geographic neighborhood retain Southern linguistic variants more than others.

In this context, the role of the individual is explored via the interaction between network clusters and social class. Broadly speaking, white collar speakers lead the shift away from Southern vowels in Raleigh. Recent work on the local occupational structure reveals a

fine-grained hierarchy of occupational areas with respect to the maintenance of Southern linguistic forms (Forrest & Dodsworth 2016). Two people with the same school network background can therefore have very different linguistic needs and different linguistic exposure as adults. Comparing speakers at distinct intersections of network and class reveals individual flexibility and agency in advancing linguistic change, even in the context of powerful social structural forces.

The second network approach uses a *relational* method. In any setting where linguistic variance increases, either due to contact, as in Raleigh, or to community-internal innovation, we expect network proximity to explain part of the variance: people who are network-proximate will be less different from one another than people who are network-distant from each other. In order to ask directly whether network exposure is correlated with linguistic behavior, we construct dyadic data (that is, data about the difference between two people) from every possible pair of individuals in the network and use the presence or absence of a network tie between each possible pair to predict their linguistic similarity. Recent relational network analysis with the Raleigh corpus (Dodsworth & Benton forthcoming) found that for some elements of the Southern Vowel Shift, co-membership in a dense, cohesive network cluster moderates linguistic difference for speakers far apart in age. Other variables, particularly /e/, were more strongly correlated with occupation. The present analysis uses the more general relational procedure of *structural equivalence,* which refers to the extent to which nodes inhabit similar positions within a social network (Borgatti 2009; Lorrain and White 1971; White, Boorman, & Breiger 1976). Because the Raleigh bipartite network consists of schools and speakers, structural equivalence in this case describes the extent to which *pairs of speakers attended the same set of schools*. A distance matrix describing each pair's structural equivalence is used to predict speakers' linguistic similarity, building on previous structural equivalence analysis of the Raleigh corpus (Dodsworth & Benton 2016). Network proximity significantly predicts linguistic similarity for some vowels, and network effects vary across apparent time.

In the context of the linguistic effects of network proximity, the role of the individual can be considered by locating pairs of speakers whose linguistic difference is greater than predicted on the basis of their network and age difference. For example, a blue collar speaker born during the early stages of contact-induced change in Raleigh shows unusually large linguistic distance from others around the same age and with equivalent network positions. It turns out that he directly manages other blue collar employees, who may have grown up in rural Southern areas where the Southern vowel system remains intact. For that reason, he has a great deal of exposure to, and motivation to use, Southern linguistic variants. But he is an outlier; other speakers with similar occupational roles do not uniformly retain Southern vowels. This speaker and others offer evidence that when the linguistic influence of non-voluntary adolescent peer network is known, it is possible to identify individual linguistic differences with respect to the retreat from Southern vowels in Raleigh. To the extent that *sound changes* also spread when people come into contact, the current bipartite network methods can be useful in understanding the social structural and individual-level factors that shape sound change.

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