Inter- and intra-regional variation in intonation: An analysis of rising pitch accents and rootedness

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JASA ARTICLE

Inter- and intra-regional variation in intonation: An analysis of rising pitch accents and rootedness

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ABSTRACT:
Regional linguistic variation is a widely known characteristic of American English, with the American South as one of the many foci. However, in much of this literature, Appalachia is lumped together with other Southern varieties. Further, the vast sociolinguistic literature has documented intra-regional variation along socio-indexical lines. However, most variation studies have focused on vocalic variation at the expense of other sources of variation, which may have different patterns and meanings. The present study was designed to explore intonational variation in conversational speech in two varieties of American English: Appalachian and Southern. Additionally, the intra-regional variation in intonation present in Appalachian English was explored considering the rootedness (local place-based attachment) of speakers. The results revealed significant effects of regional dialect on both the quantitative and qualitative realization of pitch accent. Further, intra-regional variation was significantly impacted by socio-indexical aspects, including rootedness, of individual speakers. The findings from this study demonstrate that both region and socio-indexical features are expressed intonationally and also provide motivation for additional exploration of intonational variation across and within the regional varieties of American English. © *2020 Acoustical Society of America*.
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I. INTRODUCTION

Research into the regional variation of American English is a cornerstone of linguistic inquiry in the U.S. and has been for decades. Seminal works such as *Pronunciation of English in the Atlantic States* (Kurath and McDavid, 1961; Carver, 1987) and the *Atlas of North American English* (Labov *et al.*, 2006; Thomas, 2001) demonstrated that American English is a rich tapestry of variation at the segmental level, particularly in the vowel system. Scholars have documented broad differences in vocalic pronunciation between Northern, Midland, and Southern speakers. Other linguistic atlas projects, e.g., the *Linguistic Atlas of the Gulf States* (Pederson *et al.*, 1986–93), and other smaller-scale investigations, i.e., much of the sociolinguistic literature [see Wolfram and Schilling (2016) for an overview], have demonstrated that intra-regional variation is also characteristic of American English. Much of this intra-regional variation can be used by speakers to express various cultural and social aspects of the individual, e.g., gender, ethnicity, personal identity, etc. (Wolfram and Schilling, 2016). One social aspect often signaled with speech is attachment to place (Labov, 1963), which this paper terms "rootedness" (Reed, 2016). Speakers often use various linguistic productions to reflect how they feel toward, or how closely they are attached to, the local place.

Research into variation at supra-segmental levels, such as intonation, is far less numerous than those of segmental variation. This lack of attention is beginning to change. Studies such as Clopper and Smiljanic (2011) and Arvaniti and Garding (2007) focused on intonational phenomena, and they have observed that regional varieties in American English can be quantitatively and qualitatively differentiated using intonation. Jacewicz and Fox (2015) observed that intrinsic fundamental frequency differed across region, showing that regionality impacted features were/are considered vocalically inherent. Holliday (2016) observed that intonational variation can index ethnic and bi-racial identity within a community. Burdin (2016) demonstrated differences in both relative frequency of pitch accents and the phonetic implementation of pitch accents in Jewish English and non-Jewish English. Burdin *et al.* (2018) noted differences in both the relative frequency of pitch accents and the phonetic realization of pitch accents across five American English varieties. The present study sought to continue in this vein. The goals of the current study were three-fold: (1) test whether intonational variation can distinguish regional varieties, even closely related ones, (2) evaluate whether within-region intonational variation is present, even within small communities of speakers, and (3) test whether speakers use intonation to express socio-indexical information.

Outside of the United States, intonational variation has received much more scholarly attention, and has been shown to differentiate both languages (e.g., Grabe, 1998a,b) and regional varieties within languages. In varieties of British English, Grabe *et al.* (2000), Grabe and Post (2002), van Leyden (2004), and Ladd *et al.* (2009) observed

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differences in tonal distinctions and the phonetic implementation of different tones in speech from across the British Isles. Similar differences in regional varieties have been observed in Danish (Grønnum, 1990), Dutch (Gussenhoven and van der Vliet, 1999; Gussenhoven, 2000), Italian (Grice *et al.*, 2005; Prieto *et al.*, 2005), and other languages around the world (Gilles and Peters, 2004; Jun, 2005, 2014).

In American English, a small but growing number of studies have focused on intonational variation. Arvaniti and Garding (2007) observed that speakers from Minnesota and California appeared to have different tonal inventories; California speakers maintain a three-way distinction of pitch accent in production (H*, L + H*, and L* + H), whereas the Minnesota speakers did not maintain a distinction between H* and L + H*. Further, the Minnesota speakers had an earlier alignment of the f_0 peak in the complex pitch accents (L* + H and L + H*). Clopper and Smiljanic (2011) found differences in relative frequency of phrasal boundary tones and also pitch accents between Midland and Southern speakers. Female speakers from both regions preferred L* + H pitch accents, while Southern females preferred the H- phrase accent compared to Midland females. McLarty (2018) found differences in the proportional use of pitch accents between European American and African American speakers in North Carolina (NC). McLarty (2018) found that African American speakers have a greater proportion of dramatic rises and falls of f_0, and this greater density has remained relatively stable across time. Holliday (2016) found that black/white bi-racial participants who identified as black produced longer pitch accent peak delays in conversations with black interlocutors than those produced with white interlocutors. Holliday (2016) attributed this difference to socio-indexical identity characteristics of the individual speakers and potentially that of different communities. Burdin (2016) observed that Jewish English speakers utilized more frequent rising pitch accents, particularly L + H* pitch accents, and distinct phonetic implementation of rising accents than co-territorial non-Jewish English speakers. Burdin *et al.* (2018) demonstrated that Appalachian English (AE), Jewish English, and African American English all have relatively more frequent L + H* pitch accents than Southern American English (SAE) or Midland English, with AE and Jewish English having the most frequent relative occurrence of this rising pitch accent. Further, this study observed that AE and Jewish English have higher peaks, wider rise spans, and steeper rises than African American English. These authors noted that varieties can be distinguished by either the relative frequency of pitch accents and/or the phonetic implementation of the pitch accent itself.

The present study focused on a community of AE speakers from Northeast Tennessee. The author is a member of this community, and has long standing personal and social ties to many community members, allowing and facilitating data collection. Intonation has anecdotally been named as one of the potentially distinguishing features of AE (Hall, 1942; Williams, 1992). In order to demonstrate that intonation can distinguish regional varieties, the present study compared the AE intonation with a cohort of SAE speakers from eastern NC. This NC community shares certain demographic similarities—rural and relatively small, while also being located in different linguistic regions. These two varieties (Southern and Appalachian) share many segmental, morphological, syntactic, and lexical features, yet are also perceptually distinct and have been described as being in two different dialectal areas (Labov *et al.*, 2006). Two studies have demonstrated that AE and SAE appear to have different intonational characteristics, Greene (2006) and Burdin *et al.* (2018). Greene (2006) evaluated whether or not intonation is distinctive in AE, and her research design reflected this focus. She compared speakers from Eastern Kentucky with two groups of speakers from the Switchboard Corpus (Godfrey *et al.*, 1992)—Southerners and "Mainstream" (speakers drawn from the North or West regions). Greene (2006) observed that AE had more rising pitch accents than these other varieties. However, Greene did not test for any differences in the phonetic implementation of pitch accent. One might anticipate that AE might also be distinct with respect to how speakers realize pitch accents phonetically (as in varieties in the British Isles, Ladd *et al.*, 2009). As noted above, Burdin and colleagues did evaluate how five varieties of American English phonetically implemented pitch accents. They found differences in both relative frequency and phonetic implementations of L + H* pitch accents. However, that study utilized reading data passages, and also was focused on comparing across varieties. Differences within each single variety, such as age, gender, or rootedness related differences, were not evaluated. The present study sought to fill those empirical lacunae and expand upon this previous work. First, the Southern cohort in Burdin *et al.* (2018) was drawn from several different areas of the U.S. South. Potential differences might exist across different Southern varieties. To build upon previous work, the present study focused on a single variety from the American South, and compared it to a single variety from the Appalachian South. Additionally, the present study expanded upon previous findings by comparing the phonetic implementation of pitch accents in SAE and AE conversational speech, in contrast to the read speech used in previous research. Finally, the present study investigates whether there are socially motivated intonational differences within the Appalachian cohort.

Within the AE cohort, the present investigation showed that variation in both the frequency of, and the phonetic implementation of, pitch accent varied according to various socio-indexical factors, but particularly rootedness, i.e., a sense of local place-based attachment. Due to varying levels of stigma, and crucially, how a speaker responds to stigma, there is often much linguistic variation within a single community, or even within a single family in Appalachia (Greene, 2010; Reed, 2014, 2016, 2018a,b). As a result, many linguistic features that are associated with the region carry additional socio-indexical information that speakers respond to in different ways. As Botinis (2000, p. 2) states,

"intonation is the most characteristic vocal means for communicating paralinguistic and indexical information"; thus, one might expect that intonation would be used to express socio-indexical information regarding the region. In many descriptions of the region and its culture (e.g., Jones, 1975, 1994; Abramson and Haskell, 2006), place and place attachment are central. This attachment can be much localized, potentially even to a particular parcel of ancestral land, often known as the "homeplace" (Cox, 2006). However, other research suggested (Greene, 2010; Reed, 2012, 2014, 2016) that some natives may orient *away* from the region culturally and linguistically, perhaps due to intense negative perception and stigma of the region and ways of speaking that are associated with it. Thus, intonation would be a medium with which to express or index that regional and local identity, or alternatively, to avoid using given the connection between language and place.

The focus of this study was Hancock County, TN—a rural Appalachian county, which sits on the border of the Southern and Central Appalachian regions in Upper East Tennessee (Appalachian Regional Commission, 2019). Figure 1 shows the county's location, which is shaded in the map.

The data from Hancock County were compared to data drawn from Warren County, NC. Warren County is located in eastern NC, as shown in Fig. 2. This county is considered part of the Southern U.S. dialect area, but is not close to Appalachia. However, both counties are rural and relatively small. Further, for the Warren County data, the fieldworkers were also members of the community. Thus, the two data sets were also comparable in that the speakers were discussing many things with a fellow community member. Below, participants are described in greater detail.

Based on previous literature, the present study hypothesized that there were differences in both relative frequency of pitch accents and the phonetic realization of pitch accent between SAE and AE, with AE speakers having relatively more frequent rising pitch accents, and an earlier phonetic pitch peak. Within the AE cohort, this study hypothesized that there were differences in both the relative frequency of pitch accents and the phonetic realization of pitch accents based on social factors, one of which will be rootedness, with more rooted speakers having relatively more frequent rising pitch accents and an earlier phonetic pitch peak.

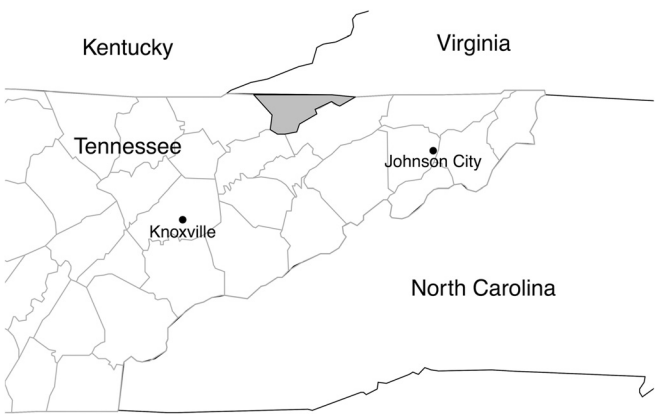

FIG. 1. The geographic location of Hancock County, TN, which represents the Appalachian cohort.

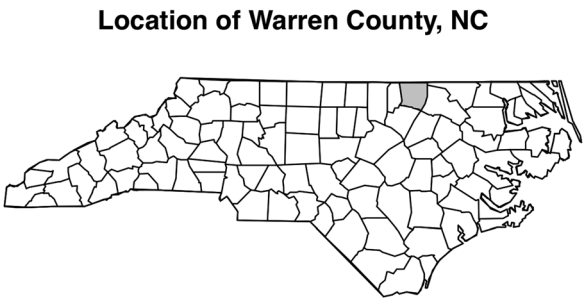

FIG. 2. The geographic location of Warren County, NC, which represents the Southern cohort.

II. METHODS

A. Participants

Twenty-five participants (13 female, 12 male) from Hancock County were recorded for analysis. Data were drawn from sociolinguistic interviews [see Tagliamonte (2006) for an overview], semi-structured interviews about a variety of topics [see Reed (2016; Chap. 3) for specifics to the present study]. Twenty-one of the participants were recorded in one-on-one interviews, while there were two sessions with pairs of interviewees.[1] All interviews were conducted by the author, who is from this same area and who was known to all interviewees previously. The resulting sample included participants stratified by gender, age, and educational level. A full list of the participants, referred to by pseudonyms to protect their identities, as well as demographic data for each participant, can be found in Table I below.

To consider whether intonation might differentiate AE from other SAE varieties, the present study compared the Hancock County speakers with a subset of speakers (4 female, 4 male) from Warren County, NC (see Hazen, 1997). The demographics of the Warren County speakers are shown in Table II.

Warren County is a relatively small rural community, located in northeastern NC near the border with Virginia, several hundred miles from Appalachia and AE varieties. The demographics of this subset of the Warren County community are relatively comparable to Hancock County.[2] Warren County is rural and has experienced recent decline in wealth and population, and Hazen observationally noted that "cultural identity is the most important social factor" for these speakers (iii). While no two communities are perfectly matched, Warren County provided a reasonable parallel for Hancock County. Thus, a comparison with a similar community helped to determine if intonational variation was a feature of rural Southern speakers in general, or

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TABLE I. Participants from Hancock County.

Name	Age	Gender/Sex	Education	Occupation	Rootedness
Haley	27	F	Bachelor's	Teacher	18
Charlotte	32	F	Associate's	Healthcare assistant	20
Rachel	35	F	Technical	Law Enforcement	31
Misty	37	F	Master's	Teacher	31
Juanita	50	F	PhD	Teacher	27
Tonya	53	F	Associate's	County administrator	29
Naomi	56	F	Master's	Teacher	23
Faith	65	F	Bachelor's	Teacher	23
Trish	68	F	Bachelor's	Retired teacher	29
Martha	73	F	High School	Retired business owner	29
Alice	77	F	Technical	Retired business owner	28
Opal	89	F	Bachelor's	Retired teacher	29
Katherine	94	F	High School	Retired factory worker	30
Joey	29	M	Bachelor's	Teacher	25
Brian	30	M	Master's	Business professional	20
Tyler	35	M	Bachelor's	Government service	19
Nathan	40	M	Technical	Business owner	26
Terry	43	M	Bachelor's	Plant manager	23
Jasper	63	M	Bachelor's	Retired company worker	30
Edward	70	M	Bachelor's	Retired county official	31
Danny	66	M	High School	County administration	30
James	69	M	Technical	Retired company worker	23
Coleman	76	M	High School	Retired business owner	29
Hugh	84	M	High School	Retired business owner	29
John	92	M	High School	Retired construction worker	29

whether there was case-study evidence for broader differences among Appalachian and Southern Englishes.

B. Materials

To arrive at a measure of local identity, i.e., rootedness, a two-part technique was employed. Using the author's ethno-linguistic understanding of the community, during the interview portion of the session(s), three questions designed to capture how each participant felt about the local county yielded three responses about personal identity and affinity toward the local area.[3] For these questions, a positive response was scored +1, a neutral response was scored 0, and an overtly negative response was −1. Thus, these scores could range from +3 to −3. These scores from these interview responses were combined with the results of the Rootedness Metric (RM), described below.

TABLE II. Demographic information for the Warren County speakers.

Gender	Age	Occupation
Female	25	Database Administrator
Female	34	Teacher
Female	77	Farmer
Female	85	Store Keeper
Male	37	Logger/Business Owner
Male	40	Teacher/Principal
Male	64	Store Keeper
Male	77	Farmer/Store Owner and Keeper

A RM survey was designed to measure local place-based attachment, which reflected the participants' affinity toward the local community and the strength of ties within the local community. Quantifying rootedness allowed for a measurable view of how localized attachment was (i.e., local community, county, East Tennessee, Appalachia as a whole), and crucially, how one speaker's rootedness compared to another. The metric asked 11 questions from seven categories: willingness to relocate, travel habits, where a participant claimed to be from (both locally and when traveling), family history, areal identification (from local community to the South as a whole), participation in local events (e.g., the local Fall Festival and other community gatherings and special events), and self-reported local identity. A full description and full text of the RM can be found in Reed (2016). These scores could range from 0 to 35. The responses to these questions were tabulated and then combined with the scores from the interview identity questions to assign a participant's rootedness score.

The highest possible rootedness score was 38, while the lowest possible score was −3 (if a speaker were to have all negative responses to the interview questions). The distribution of rootedness scores is shown in Table I. The highest actual score was 31, from three participants (Edward, Misty, and Rachel). The lowest actual score was 18, from Haley. The average rootedness score was 25.95 and the median rootedness score was 28; thus, in the aggregate, participants seemed to be fairly rooted to Hancock County. The average rootedness score for female speakers was

26.15 and the median was 29, whereas the average rootedness score for males was 25.74 and the median was 26. Thus, in the aggregate, females were slightly more rooted than males. The range of scores was 13 (18 to 31) for females and 12 (19 to 31) for males. Age and rootedness have a fairly strong positive correlation ($r = 0.62$), meaning that older speakers tend to have higher rootedness scores. This correlation is understandable, as older participants have chosen to stay in the county, which could be attributed to a somewhat stronger local attachment.

C. Analysis

The current study examined the variation in the phonetic realization of pitch accents among Appalachian speakers and also compared these realizations to those of other Southerners. The present study analyzed 100 pitch accent tokens per participant, corresponding to about 3–5 min of speech from each interviewee. In an effort to analyze a stretch of speech that was relatively uninterrupted, these data were drawn from the middle of the conversational portion of the interview for each participant. This was when the participants were discussing their childhoods, memories, and other aspects of life in Hancock County. For the Warren County data, a similar stretch of speech was located wherein the participant was narrating a story of a comparable topic (Warren County, life there, etc.).

Each stretch of speech was labeled using a modified version of the ToBI guidelines from Beckman and Elam (1997) and Beckman *et al.* (2005). The modification was needed based on the number of speakers analyzed, and also because of the nature of ToBI analysis. ToBI relies on a grammatical and information structure analysis of a given variety (e.g., MAE_ToBI). Since the intonational grammar and also the informational structure of Appalachian and Southern Englishes are not rigorously described, the present paper used a version of the ToBI system as a transcription tool for sociolinguistic analysis. Certain terminology (e.g., the pitch accent labels) was used to make the present paper comparable to previous (and related) studies. However, certain aspects of other ToBI analysis (such as focus and prominence) were left for subsequent analysis.

ToBI involves marking all tones and break indices. Tones include pitch accents, intermediate phrases, and boundary tones. Break indices mark the perceived disjuncture between elements.[4] First, syllables that had phrasal prominence were identified using a combination of auditory listening and visual inspection of the pitch track and marked (with *) and phrase boundaries were identified and noted (marked by −). For the prominent syllables, f_0 movements (from visual inspection and repeated listening) yielded the classification of the associated pitch accents. According to the ToBI annotation system, American English has five pitch accent tones, a high tone (H*), which is the most common, a low tone (L*), and their combinations, L + H* and L* + H.[5] The difference between these latter pitch accents is that the L* + H may extend into the following syllable, whereas L + H* stays on the accented syllable (Arvaniti and Garding, 2007, p. 3). Each of these L + H combinations has been claimed to be used for emphasis (e.g., Pierrehumbert and Hirschberg, 1990). The fifth pitch accent identified is H +! H* (typically used to express annoyance or indignation).[6] Intermediate phrasing, marking slight juncture (break index 3), is marked by a hyphen (-). These tonal markers, a High (H-) or Low (L-), reflect a small juncture in the phrasing. Commonly, these occur after vocatives or certain discourse connecting phrases (e.g., *Well*) target at the edge of a phrase. Boundary tones, marked by %, are edge tones that reflect the end of an intonational phrase, usually a pause. The end of an intonational phrase is also the end of an intermediate phrase, and thus the two are written concurrently at the right boundary, e.g., L-L%. There are four combinations—L-L%, H-H%, H-L%, and L-H%. L-L% marks the end of a falling declarative statement, H-H% marks the high rise for a typical yes/no question (this can also happen for high rising terminal), H-L% is a high level tone often associated with reciting lists, and L-H% is often used as a "continuation rise" for when a speaker wishes to continue speaking. After labeling these conversational stretches of speech following these ToBI guidelines, all occurrences of each of the different pitch accents were tabulated.[7]

The present study also examined how rising pitch accents (L + H* in particular) were phonetically realized, as this pitch accent has been found to be more prevalent in certain American English varieties (e.g., Burdin *et al.*, 2018). Research in varieties of British English, such as Grabe *et al.* (2000), Grabe (2004), and Ladd *et al.* (2009), and in American English, Arvaniti and Garding (2007), has found that the phonetic realization of pitch accents can distinguish different varieties. The present study measured the peak alignment of L + H* pitch accents (the second most frequent pitch accent in the present study for most speakers) to determine the alignment of the pitch accent peak, one phonetic feature that was observed to vary in the above-cited studies. Using a methodology similar to that outlined in Ladd *et al.* (2009), a measure from the onset of the vowel containing the pitch accent to the highest pitch point yielded the pitch accent onset (PA-On).[8] The PA-On was derived from the difference in milliseconds from the onset of the vowel of the rising pitch accent to the highest pitch point.

As one further measure, the excursion of the pitch accent for each rising pitch token was measured. Excursion is the change from the local pitch minimum to the local pitch maximum. Greene (2006) suggested that some of her speakers with relatively high rates of L + H* occurrence may have had more extreme pitch changes (i.e., excursions). She measured the scaling of the average L + H* (taking the average maximum f_0 of the L + H* tokens and dividing by the difference of $f_{0_{max}}$ minus $f_{0_{min}}$), and found no obvious differences. However, she averaged across speech varieties and did not investigate individual speakers or individual tokens. Averaging across varieties does not allow for the detection of any intra-group differences, which was not

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a focus of her study. However, she suggested that individuals or subgroup differences may exist. To calculate the excursion, a measure of the difference in f_0 from the previous minimum pitch trough (the lowest f_0) to the pitch accent peak (the highest f_0 in the pitch accent) for each L + H* token was performed (following the methodology in Thomas, 2011, p. 212). To cancel out some of the differences across speakers due to physiology, f_0 measures were converted to the equivalent rectangular bandwidth (ERB) scale (cf. Thomas, 2011, p. 226).[9]

III. RISING PITCH ACCENT DISTRIBUTION

To examine how speakers might use rising pitch accents as a feature of local varieties of AE, the present study compared the frequency of realization of L + H* with speakers from Warren County in Sec. III A. below. For variation within AE itself, a comparison of how different social factors impacted the frequency of L + H* realization is discussed in Sec. III B. A series of mixed effect regression analyses was conducted to determine the relative impact of the social factors. For the relative frequencies of the pitch accents, mixed effect logistic regression models were fit using the lme4 package in R (Bates *et al.*, 2015). The first model included the variety spoken as an independent variable, comparing AE to SAE. In the second model, the focus was solely on the Appalachian speakers from Hancock County, testing for the influence of social factors within the population.

A. Pitch accent frequency: Comparison with Warren County

The first model was a comparison of the frequency between the Appalachian speakers from Hancock County and the Southern speakers from Warren County. In this model, speaker dialect (Appalachian or Southern) was coded as a treatment contrast, with Appalachian serving as the reference, speaker gender (male or female), speaker age (as a continuous variable), and all possible two- and three-way interactions were treated as fixed independent variables, while the individual speaker was treated as a random effect with random intercepts. Realizations of L + H* were the dependent variable, with an L + H* coded as 1 and other pitch accents coded as 0. To obtain *p*-values, likelihood ratio tests of the full model including the fixed effect in question against a reduced model absent the fixed effect were compared.

Within this model, a main effect of variety was significant [$\chi(1) = 51.644$, $p = <6.655 \times 10^{-13}$]. If one looks at the average numbers of L + H* for each variety, as shown in Table III, it is apparent that the Appalachian speakers from Hancock County use many more L + H* pitch accents out of the 100 counted pitch accents than do the Southern speakers of Warren County. Further, similar to results found by Greene (2006) in Eastern Kentucky, the proportion of L + H* pitch accents was far greater for the Appalachian speakers in Hancock County, bolstering the claim that relatively frequent rising pitch accents are an AE feature.

TABLE III. Average pitch accent frequency (out of 100) for the Hancock County speakers and the Warren County speakers. Average proportion of L + H* accents are shown relative to the number of H* pitch accents.

Variety	Average L + H* count	Proportion of L + H*/H*
Hancock County—Appalachian	28.8	0.49
Warren County—Southern	10.25	0.12

From these results, one can see that the Hancock County speakers have a far greater overall number and proportion of L + H* pitch accents compared to the Warren County speakers. These results support those of Burdin *et al.* (2018), which found that AE had relatively frequent rising pitch accents in reading data. Here, a similar result emerged for conversational data. Thus, it appears that relatively frequent rising pitch accents are a feature of AE that might distinguish it from other varieties of Southern English, creating a unique profile in conjunction with other phonetic and phonological phenomena. Further, although the two varieties share many segmental, lexical, and syntactic features, this intonational difference does not appear to be shared with other SAE varieties, when one considers these conversational results and the read speech results of Burdin *et al.* (2018).

B. Pitch accent frequency comparison among Hancock County speakers

Hancock County speakers in the aggregate were very similar to the participant cohort in Greene (2006). The most frequent pitch accent was H*, followed very closely by L + H*. Figure 3 shows the distribution of the five types of pitch accents in Appalachian speech. The frequency of L + H* was not significantly different from the L + H* frequency from speakers in Greene's study.[10] She found that this relative frequency of L + H* was significantly different from Mainstream English varieties in addition to Southern English. Burdin *et al.* (2018) corroborated this finding in read speech. Figure 3 shows the pitch accent distribution per Hancock County speaker. Note the wide ranges in counts of H* and L + H* in particular.

To better understand how the social factors of gender, age, and rootedness impacted the relative frequency of L + H*, a mixed effects logistic regression analysis was performed using lme4 (Bates *et al.*, 2015) in the R statistical program (R Core Team, 2015). Speaker age, speaker gender, education, and rootedness as measured by the RM with two- and three-way interactions were included as fixed independent variables, with individual speaker as a random effect with random intercepts. Main effects of age [$\chi(1) = -3.683$, $p = 0.0002$] and rootedness [$\chi(1) = 3.401$, $p = 0.00067$] were significant in the model, as well as the age × rootedness interaction [$\chi(1) = -3.591$, $p = 0.00033$]. The relative frequency of pitch accents by age is shown in

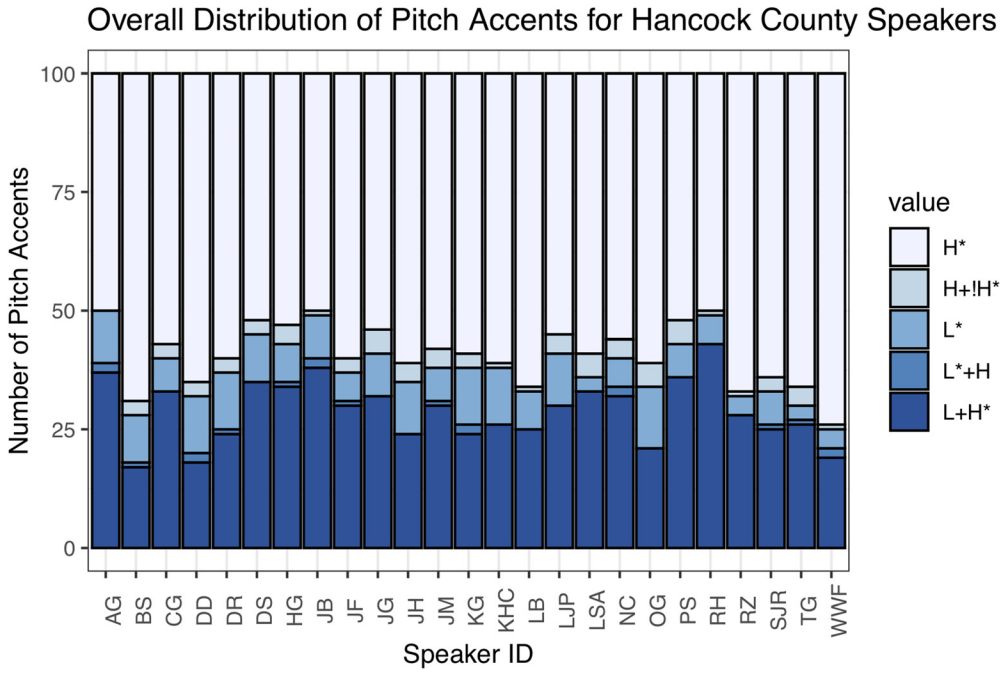

FIG. 3. (Color online) Overall distribution of pitch accents for individual Hancock County (Appalachian) speakers.

the left panel of Fig. 4, the frequency by rootedness is shown in the right panel.

As these figures show, older speakers in Hancock County used relatively more L + H* pitch accents than younger speakers, and more rooted speakers produced relatively more L + H* than less rooted speakers. These results are discussed below.

C. Pitch accent frequency discussion

The results above in Sec. III A revealed regional variety effects on the relative frequency of pitch accents. Consistent with Greene's (2006) finding in Eastern Kentucky, the Hancock County speakers have a much higher relative frequency of L + H* pitch accents than the speakers from Warren County. This finding suggests that relatively frequent L + H* pitch accents appear to be a feature of AE.

Among the Hancock County speakers, the results from Sec. III B showed that both age (model estimate 0.044) and rootedness (model estimate 0.088) had an effect on the frequency of L + H* pitch accents. Older speakers had relatively more L + H* accents than younger speakers, and more rooted speakers had relatively more L + H* accents than nonrooted speakers. However, rootedness had twice the magnitude of age. The interaction (model estimate −0.0014) indicates that rootedness may be less important for older speakers. Age and rootedness are correlated within Hancock County (Pearson correlation 0.56), so this is not unexpected.[11] It appears that relatively frequent rising pitches are a signal of belonging to the local area, which can derive from being more rooted or from living there for a more extended period of time. The more strongly a person is attached to the local area, i.e., the higher the rootedness score, the more frequent their L + H* pitch accent.

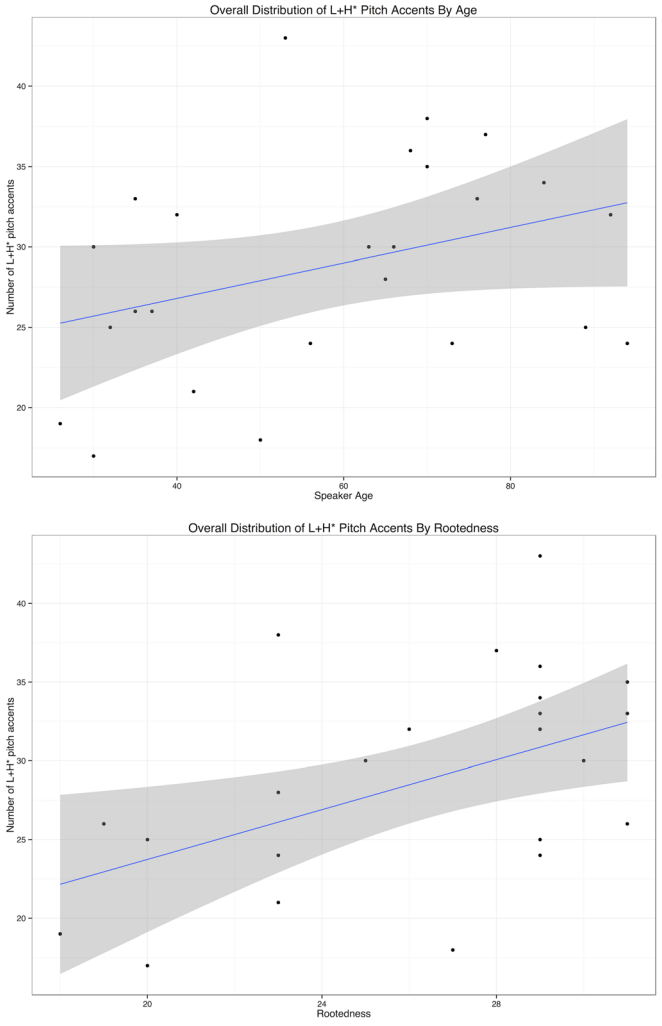

FIG. 4. (Color online) The distribution of pitch accents by speaker age in the upper panel and by speaker rootedness in the lower panel.

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IV. RISING PITCH ACCENT REALIZATION

To further expand upon the findings from Sec. III, the present study investigated the alignment of the H tone within the L + H* pitch accent using the PA-On measure (see Sec. II for methodology) to determine if the phonetic realization of pitch accents was socially meaningful. First, a comparison of the PA-On from the Hancock County speakers and the Warren County speakers is discussed in Sec. IV A. The results above indicated that the Hancock County speakers had a higher occurrence of L + H* pitch accents than the Warren County speakers. Thus, a natural next step was to determine if the phonetic implementation of the pitch accent differed, similar to the findings of Burdin *et al.* (2018). Second, to determine how PA-On varied within the Hancock County cohort, an analysis of PA-On within the Hancock County speakers themselves is discussed in Sec. IV B, testing for the relative impact of social factors upon the phonetic realization of the L + H* pitch accent.

A. Pitch accent onset comparison with Warren County

To analyze whether the two varieties realized L + H* differently with respect to PA-On, a mixed effect linear regression analysis was performed. In this model, speaker dialect, speaker gender, speaker age, and all possible two- and three-way interactions were treated as fixed independent effects, while the individual speaker was treated as a random effect with random intercepts. The PA-On was the dependent variable.

A likelihood ratio test which compared the full model with the fixed effect against a reduced model without the fixed effect yielded p-values. The likelihood ratio tests revealed that speaker dialect was significant [$\chi(1) = 7.7382$, $p = 0.005407$], increasing PA-On by 24.6 ± 8.36 (standard errors). Thus, Hancock County (Appalachian) speakers have a shorter PA-On than Warren County (Southern) speakers.

Figure 5 illustrates the difference between the two varieties in average PA-On values. The Hancock County (Appalachian) speakers had a lower average PA-On than the Warren County (Southern) speakers.

From these results, one can see that Hancock County speakers have an earlier alignment of the L + H* peak than the Warren County speakers. Such a difference in alignment is not unexpected across regional varieties. Arvaniti and Garding (2007) found differences in rising accent peak alignment between Minnesota and Southern California speakers, with the Minnesota speakers having earlier alignment. Further, Ladd *et al.* (2009) found differences in peak alignment between Scottish English and Standard Southern British English (SSBE) in the British Isles, with the SSBE having an earlier alignment. Continued findings of pitch accent peak alignment differences bolster the claim that intonation varies across region akin to segmental variation. The findings here, that AE speakers are distinct from SAE speakers, bolster the claim that AE might have a characteristic intonation. As such, this feature indexes an identifiable group, here AE speakers, and might serve as an indicator

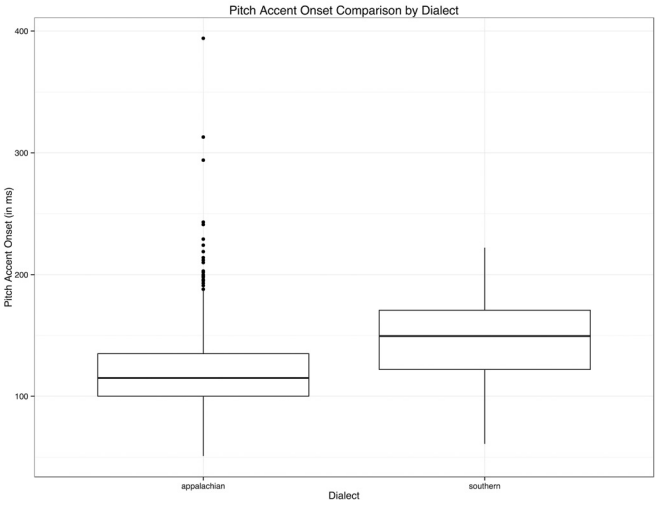

FIG. 5. Comparison of PA-On between Hancock County speakers (Appalachian) and Warren County speakers (Southern).

and thus is available to possibly signal further social meaning, i.e., be a marker.

B. Pitch accent realization within Hancock County

Focusing on the variation of PA-On within Hancock County, a mixed effect linear regression analysis was conducted to determine the relative impact of various social factors. In the model, speaker gender, speaker age, speaker education, and rootedness were included as independent fixed effects, while individual speaker was a random effect with random intercepts. PA-On was the dependent variable.

As above, p-values were obtained from likelihood ratio tests of the full model including the fixed effect in question against a reduced model absent the fixed effect. Rootedness [$\chi(1) = 4.8861$, $p = 0.02707$] was the only significant effect. More rooted speakers had an earlier PA-On, as rootedness decreased PA-On by −4.48 ± 2.849 (standard errors). Figure 6 displays this relationship graphically.

From these results, one can see that more rooted speakers had earlier aligned peaks for L + H* pitch accents. An earlier alignment is perhaps more Appalachian, as the difference between the Southern (Warren County) speakers and the Appalachian (Hancock County) speakers was that the Hancock speakers had an earlier aligned peak. This could mean that less rooted speakers utilized a phonetic realization that is more like some type of supra-regional norm, i.e., the broader American South.

C. Pitch accent realization discussion

The results above in Sec. IV A suggested that the Warren County speakers, here representing SAE, have a longer PA-On than the Hancock County speakers representing AE. Focusing on the variation within the Hancock County speakers in Sec. IV B, the results revealed that more rooted speakers have a shorter PA-On and thus earlier peaks. One might then conclude that more rooted speakers

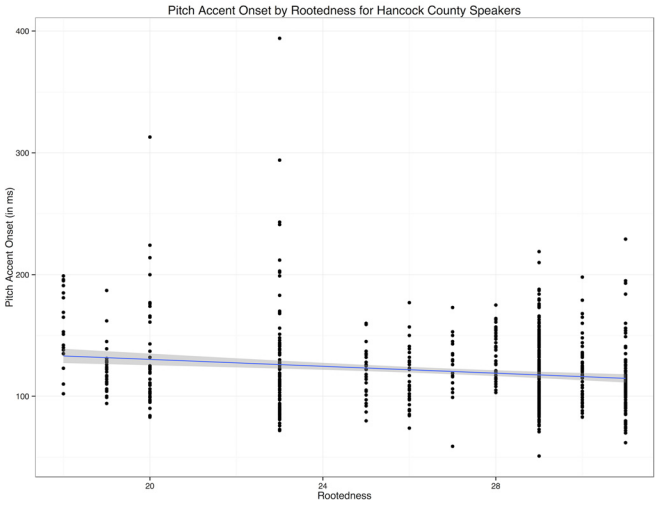

FIG. 6. (Color online) Graph of PA-On by speaker rootedness for Hancock County speakers (Appalachian).

utilized a feature more associated with AE. It is reasonable to conclude that more rooted speakers used features more strongly associated with the local area, and those that are less rooted might have approximated a broader regional norm, which might be less associated with the local area.

V. PITCH EXCURSION

The final pitch accent analysis was to evaluate what relative impact social factors had on pitch excursion. Excursion is the change from the local pitch minimum to the pitch maximum. The degree of excursion may explain alignment differences in pitch accent peaks described in Secs. IV A and IV B.

A. Pitch excursion comparison with Warren County

To determine if the excursion of the L + H* pitch accent was realized differently between the Hancock County and Warren County speakers, a mixed effects linear regression model analysis was conducted. Speaker dialect, speaker age, and speaker gender were included as fixed independent effects. Individual speaker was included as a random effect with random intercepts. The excursion in ERB was the dependent variable. After running likelihood ratio tests, no main effects or interactions were significant.

This result indicates that the change from low to high was not different between the two dialects. Since the alignment was later for the Warren County speakers, one explanation could be that they had a greater change in pitch, i.e., that their excursion would be greater. It would take more time to physically make this change in pitch, and thus their alignment would be later. However, no effect was found. This means that the change in pitch for the two varieties was not significantly different, and the Hancock County speakers did align their pitch peaks earlier.

B. Hancock County excursion analysis

A mixed effect linear regression analysis was conducted on the excursion of the Hancock County speakers. Speaker age, speaker gender, speaker education, rootedness, and all two- and three-way interactions were included as independent fixed effects. Individual speaker was included as a random fixed effect. The excursion in ERB was the dependent variable. After running likelihood ratio tests of models including the fixed effect in question and those without the fixed effect, no significant differences were found.

This result means that the change from low to high was not different within the Hancock County speakers. Since the more rooted speakers had earlier alignment, and less rooted speakers had later alignment, a difference in excursion could explain this difference (similar to the possibility outlined above in Sec. V A). Since there was no difference, speakers had similar changes from low to high, and the difference truly lies in the PA-On, the peak alignment.

VI. GENERAL DISCUSSION

The results from the Hancock County/Warren County comparison (Sec. III A) revealed that intonation may differentiate some Appalachian varieties from some other Southern varieties. Hancock County speakers had a higher relative frequency of L + H* pitch accents, and the PA-On of the L + H* pitch accents was anchored earlier in the syllable. These two findings suggest that pitch variation might very well be a way to distinguish two closely related language varieties. Other research (e.g., Labov *et al.*, 2006) has shown segmental differentiation of the upland South, which includes Appalachian East Tennessee. As more attention is paid to regional variation in intonation, one can expect that, like segmental variation, intonation can distinguish region. The present study has lent support to this idea.

Turning to variation within Hancock County, results suggested that a traditional social factor had an impact—age on the relative frequency of pitch accent. However, it appears that rootedness also plays a role in understanding the intonational variation present in this Appalachian community. In interactions with traditional social features, rootedness affected both the distribution of pitch accent and the phonetic implementation of pitch accent. The speakers who were more rooted had relatively more frequent L + H* pitch accents and an earlier PA-On. From this, speakers seemed to be aware of the various linguistic means available to express a local orientation, and used them (perhaps at a subconscious level) to demonstrate how they felt about the local area.

Community members were aware of what it means to sound local. When asked about how local people sound, several community members appeared to reference intonation alongside other segmental features [see Reed (2016) for segmental reactions]. For example, Tyler, a 35 year old male, mentioned during our interview several times how you can tell a local by the way he/she talks, specifically "the melody." He referred to it as "artwork," something that

is "so cool." He specifically mentioned that for his work, which required much interaction with the public, he used his manner of speaking as a way to make his clients feel more comfortable. He implied that if someone does not sound local, then clients are not at ease, and any interaction becomes much more difficult due to a lack of trust. Others consistently mentioned that locals had a certain "tone," and from their descriptions, it seemed more that the intonation was the crucial aspect. Trish, a 68 year old female, talked about how people that move in do not have the same tone and, like above, she seemed to be referring to intonation. When pressed, she did not mention any particular vowel sound or lexical items; she said once again, "the way they talk." Such anecdotes indicate that male and female speakers, across the age continuum, were aware of the intonational variation present in the community, even if they were not able to pinpoint what they perceive. Thus, intonation forms part of what it means to "sound local." Community members may not have metalinguistic awareness of intonational cues in local speech, such as being able to name pitch, pitch accent, or intonation. Nonetheless, speakers utilize intonational differences that reflect their local place-based attachment.

Furthermore, these references demonstrate that localness mattered with regard to a feature that is less widely known and overtly commented on than one such as /ai/ monophthongization (Bernstein, 2006). For a well-known and commented feature like /ai/ monophthongization, one can hear caricatures in the media, find books that utilize respellings to emphasize the differing pronunciation (e.g., Venable, 2013), and show a widespread enregisterment (Agha, 2003) of the feature. There exists a widespread idea that using monophthongal productions is a means to sound Southern and/or Appalachian, and thus might be more present in circulating discourse. In contrast, intonation has not received the same type of attention in either the linguistic or popular literature as monophthongization, yet it can differentiate more rooted speakers in a similar fashion (cf. Reed, 2014). Hancock Countians seemed to notice differences in intonation, even differences in pitch accent frequency or the difference in pitch peak alignment. These features, while perhaps not as salient as monophthongal /aI/, nonetheless can allow a speaker to demonstrate his/her local attachment.

[1]These pair sessions were necessitated by a snowstorm and difficulty of travel.

[2]Warren County does have a sizable African American community, while Hancock County does not. However, Hazen (1997, p. 51) noted clear ethnic and social divisions between the two groups with little social and/or cultural interaction. Further, the fieldworker was a member of the white community, making the data collection more comparable.

[3]This methodology roughly follows that employed by Haddican *et al.* (2013) in Northern England. The questions were: (1) Do you like Hancock County? Why/why not?; (2) Do you consider it to be "home"? Why/why not?; and (3) Do you think that it is part of who you are? Part of your identity?

[4]A 0 marks interword boundary, typically used for contractions. A 1 is a typical word boundary. A 3 marks the end of an intermediate phrase, with a slight disjuncture. This would also receive an intermediate phrasal tone. A 4 marks the end of the intonational phrase and receives a boundary tone. A 2 indicates a mismatch between the perceived juncture and the tonal marking. Thomas (2011, p. 206–207) states that break indices have limited utility for sociophonetics, as they are largely redundant with boundary tones or word boundaries.

[5]The * marks the tone that is associated with the accented or stressed syllable.

[6]The ! stands for a downstepped pitch accent. Downstepping occurs when several pitch accents of the same type occur in succession. Each successive pitch accent may be slightly lower than the preceding one, thus *downstepped*.

[7]To insure reliability, the author re-coded all data included in the study. The Cohen's κ was 0.9. In previous work (Burdin *et al.*, 2018), the author's coding was checked by a colleague not involved in this study. The agreement was over 90%. I thank a reviewer for the suggestion of a reliability check.

[8]Burdin *et al.* (2018) measured from the onset of the vowel. To maintain comparability, the present study also measures from the onset.

[9]The formula for the conversion is $\mathrm{ERB} = 16.7\log_{10}(0.006046f + 1)$.

[10]A goodness of fit chi-squared test resulted in $\chi(1) = 0.10973$, $p = 0.7405$.

[11]Collinearity was tested with variation inflation factor (VIF) in R. The VIF was 2.8, which indicates that multicollinearity should not be a problem to model.

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