

## ABSTRACT

We examine distinctiveness among four vowels /i, e, ε, a:/ in Appalachian English in the perception of children (9-13 years) and adults (50-65 years) who spoke the same local variety as the talkers who produced the stimuli. Each listener responded to unique exemplars of *beds*, *beds*, *beds*, *bides* (both stressed and unstressed) produced by 40 talkers, male and female, children (8-12 years) and adults (50-65 years). The highest identification rates were for *beds*, the lowest for *bides*. For each vowel, stressed variants yielded slightly higher rates than unstressed. Examination of confusions among spectral neighbors revealed systematic confusions between *bids* and *beds*. Confusions for *beds* and *bides* varied as a function of talker age and gender and listener age, reflecting effects of cross-generational sound change in this dialect. In a second task, the vowels were presented in *IVd*-frame and stimulus uncertainty was elevated by increasing the number of vowel categories (12), talker age groups (3) and the addition of another dialect. Similar pattern of responses was obtained by different listeners (children and adults) but overall identification rates were comparatively higher. Altogether, these results show listener sensitivity to cross-generational sound change which affects both vowel position and formant dynamics. [Work supported by NIH.]

## Experiment 1: *bVd* context

The regional vowel system of the variety of Southern American English spoken in Western North Carolina (Inland South) is currently undergoing a set of positional and spectral changes. We examine listeners' ability to make distinctions among vowels and their sensitivity to the sound change affecting the vowel subset /i, e, ε, a/.

This cross-generational sound change is manifested in positional lowering of /i, e, ε, a/ in the vowel space and reduction of their formant movement (Jacewicz *et al.*, 2011). Based on the acoustic characteristics, these vowels become more "monophthongal" in children compared to adults, losing their Southern breaking (see Figure 1). The monophthongal version of /a/ in adults mostly disappears in children who produce it as a true diphthong. Experiment 1 examines the perceptual distinctiveness of the vowels in listeners representing two generations (adults and children). Both emphatic and nonemphatic variants are used in the listening task to observe the effects of clarity of production on vowel identification.

### Listeners

- 16 adults, 50-65 years old
- 12 children, 9-13 years old.
- All were ordinary listeners (naïve to perceptual testing), spoke the local dialect and have not left the area for extended periods of time.

### Stimuli

- The words *beds*, *beds*, *beds*, *bides*, *bedes* were produced in both emphatic and nonemphatic positions in a set of tightly controlled and matched sentences.
- The speech material was recorded by 40 speakers of the local dialect: 20 children (10 males, 10 females, 8-12 years old) and 20 adults (10 males, 10 females, 50-65 years old).
- The target words were extracted from sentences and equalized for mean intensity.
- A total of 400 isolated words was presented for identification (5 words x 2 stress levels x 40 speakers).

### Procedure

- Testing was done in a quiet room at Western Carolina University. Sound was delivered diotically over Bose QuietComfort 2 headphones. Stimulus presentation and response collection were controlled by a custom MATLAB program.
- Listeners heard one word at a time and indicated their response by selecting one of the seven choices (boxes) on the monitor: *beds*, *bids*, *beds*, *beds*, *bides*, *bedes* and *buds*.
- The experiment was self-timed and no more than one repetition was allowed. A practice run (using 20 tokens not used in the perception test) was administered prior to the experiment.

## Stimulus vowels

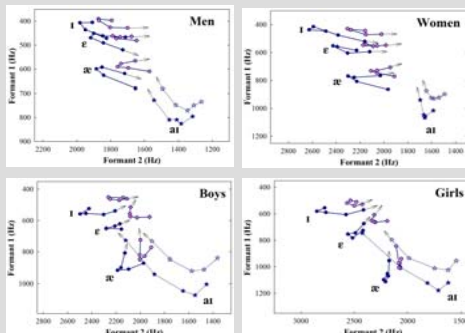


Figure 1. Dynamic formant patterns for the NC vowels /i, e, ε, a:/ in *bids*, *beds*, *bedes*, *bides* used as stimuli in Exp. 1. Shown are mean F1 and F2 values for five equidistant time points (20-35-50-65-80%) over the course of a vowel's duration in emphatic (solid blue points) and nonemphatic variants (see Fox & Jacewicz, 2009, for further details). Means (unnormalized) are for 10 speakers in each age and gender group.

## Identification results

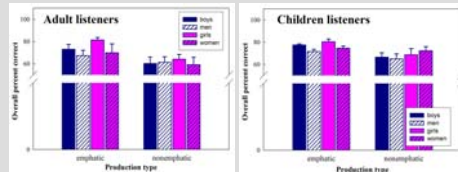


Figure 2. Overall percent identification of /i, e, ε, a:/ as intended by speakers (boys, men, girls and women). Shown are results for adults and children. The results for /a/ in *bedes* are not included in this and following analyses.

### Adult listeners

- ANOVA results (after arcsine transformation, Studebaker, 1985) using the within-subject factors vowel, emphasis, gender and age:
- Emphatic vowels had significantly higher identification rates than nonemphatic vowels (in RAU: 74 vs 61) [F(1,15)=94.2, p<0.001].
  - Children's vowels had higher rates than adults' (70 vs 65 [F(1,15)=7.87, p=0.013]).
  - Significant main effect of vowel: no difference between /i/ and /e/ (84 vs. 80); significant differences between /a/ (64) and /a:/ (42) and all comparisons with /i, e/
  - Gender was not significant.
  - Significant vowel by age interaction: /i/ had higher rates when produced by adults, /e, a/ when produced by children, and there was no difference for /a/.

### Children listeners

- Emphatic vowels had significantly higher identification rates than nonemphatic vowels (in RAU: 77 vs 68) [F(1,11)=37.7, p<0.001].
- The main effects of vowel, age and gender were not significant.
- Significant vowel by age interaction: results exactly as for adult listeners.

## Confusion patterns for *beds* and *bides*

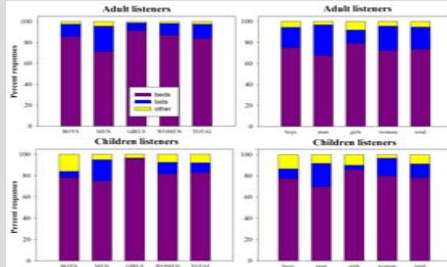


Figure 3. Identification and confusions for /i/ in *beds*. This vowel was identified mostly as intended by speakers. Children confused it less with /i/ compared to adults.

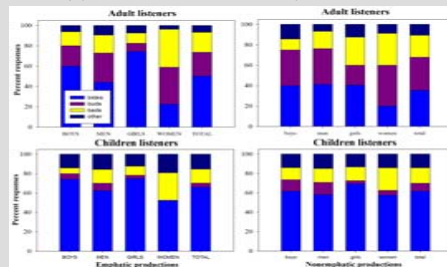


Figure 4. Identification and confusions for /a/ in *bides*. Vowels produced by children had higher identification rates. Adult listeners choose the response *buds* more often than children did.

## Experiment 2: *hVd* context

Exp. 2 used 12 citation form tokens *head*, *hid*, *heyd*, *head*, *had*, *hod*, *hawed*, *hoed*, *who'd*, *hood*, *hojd*, *hide*, *howed* produced by three generations of North Carolina speakers (children, 8-12, young adults, 35-50, and old adults, 66-91) and the equivalent three generations of Wisconsin speakers (representing a different dialect). There were 10 males and 10 females in each subgroup for a total of 120 speakers.

North Carolina listeners (15 adults, 12 children, different than in Exp. 1) identified the tokens using similar experimental set up and procedures as in Exp. 1. The level of difficulty was elevated by the increased number of response choices (12) and addition of the Wisconsin dialect.

The results are presented for North Carolina subset /i, e, ε, a:/ only.

- Adult listeners: 73% male speakers, 76% female speakers;
- Children listeners: 75% male speakers, 83% female speakers.

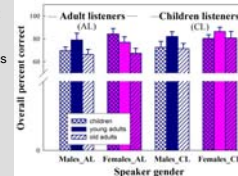


Figure 5. Overall percent identification of North Carolina /i, e, ε, a:/ as intended by North Carolina speakers (three generations of males and females). Shown are results for adult and children listeners.

## Confusion patterns for *head* and *hide*

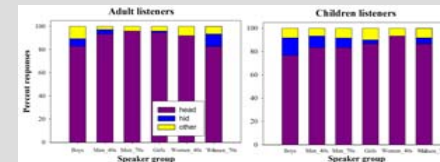


Figure 6. Identification and confusions for /i/ in *head* by adult and children listeners.

- ID rates for *head* were higher than for *beds* in Exp. 1 (emphatic/nonemphatic):
- Adult listeners: 90.2% (*head*) vs. 83.8% (emphatic) and 73.6% (nonemphatic)
- Children listeners: 85% (*head*) vs. 82.7% (emphatic) and 78.3% (nonemphatic)

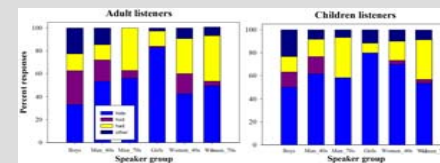


Figure 7. Identification and confusions for /a/ in *hide* by adults and children listeners.

- ID rates for *hide* were higher than for *bides* (emphatic/nonemphatic):
- Adult listeners: 52.9% (*hide*) vs. 50.2% (emphatic) and 35.5% (nonemphatic)
- Children listeners: 71.7% (*hide*) vs. 66.1% (emphatic) and 61.7% (nonemphatic)

## Summary

- Experiment 1 showed relatively high ID rates for /i, e, ε/. The greater spectral separation of the two vowels in girls corresponds to lesser confusions of /e/ with /i/; the same result was found in Experiment 2, which suggests perceptual sensitivity to sound change in progress.

- ID rates for /a:/ in both experiments were higher for children productions compared to adults and the vowel was less confused with /e/. Again, this response pattern seems to reflect listener sensitivity to lowering of /a/ in children.

- ID rates for /a/ were low in response to adults' productions and increased for girls, indicating listener sensitivity to the greater diphthongal change in girls.

- Overall, the ID rates were higher in Experiment 2 despite more difficult listening conditions (120 speakers and two dialects) than in Experiment 1 (40 speakers and one dialect). The general pattern of responses was consistent across the two experiments.

## REFERENCES

Fox, R. A. and Jacewicz, E. (2009). Cross-dialectal variation in formant dynamics of American English vowels. *Journal of the Acoustical Society of America*, 126, 2603-2618.  
 Jacewicz, E., Fox, R. A. and Salmons, J. (2011). Cross-generational vowel change in American English. *Language Variation and Change*, 23, 1-42.  
 Studebaker, G. (1985). A "Rationalized" arcsine transform. *Journal of Speech and Hearing Research*, 28, 455-462.

## ACKNOWLEDGMENT

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