3

A Controlled Experiment on Vowel Identification

This chapter will pursue the investigation of the cognitive consequences of linguistic change that was initiated in Chapter 2. While Chapter 2 examined evidence on the effect of dialect differences in everyday life, this chapter will present the results of controlled experiments that measure with greater precision the effects of sound changes in progress on the ability to recognize the vowel phonemes of English. If nineteenth-century grammarians were right in asserting that sound change has a destructive effect upon the central functions of language (Chapter 1 of Volume 2), we should find that changes in progress interfere with the identification of words and their meanings, not only across communities but within the community as well.

The experiments reported here were carried out by the project on Cross-Dialectal Comprehension [CDC],[1] which focused on three cities in which sound changes were moving in radically different directions:

- Philadelphia, the site of the new and vigorous changes described in Chapters 4 and 5 of Volume 2;
- Chicago, the largest city undergoing the Northern Cities Shift [NCS], as defined in Volume 1; in ANAE, Chapters 11 and 14; and in Figure 1.4 of this volume;
- Birmingham, prototypical site of the Southern Shift, as defined in Volume 2; in ANAE, Chapters 11 and 18; and in Figure 1.5 of this volume.

To create the stimuli for the experiments, we located and recorded in each city speakers who could be expected to represent the leading edge of sound change in the speech community. Volume 2 found that the leaders of linguistic change are most likely to be found among upwardly mobile women from the upper working class and lower middle class. The Project on Linguistic Change and Variation [LCV] of the 1970s had identified and recorded leaders of linguistic change in Philadelphia, using open reel Nagra tape recorders and high-fidelity lavalier

microphones. To obtain comparable recordings in the other two cities, we selected in Chicago and Birmingham the major local state-supported commuter colleges, with a high proportion of local residents, many of them being the first in their families to go to college. These were the University of Illinois in Chicago (UIC) and the University of Alabama in Birmingham (UAB). Sharon Ash carried out interviews with first-year women in both of these colleges in 1988.[2]

3.1 The Peterson–Barney Experiment

The title of this chapter is taken from the well-known experiment of Peterson and Barney in 1952, designed to test listeners' ability to identify the vowels of words spoken in isolation. Peterson and Barney presented ten vowels in the frame /h_d/: *heed*, *hid*, *head*, *had*, *hod*, *hawed*, *hood*, *who'd*, *hud*, *heard*, as pronounced by 76 different speakers, including men, women and children. Most of the speakers were said to be speakers of "general American," a category no longer recognized in American dialectology, but confusion in the *hod/hawed* area points to the fact that some speakers exhibited the low back merger.

Peterson and Barney raised the issue of determining the reference grid by which listeners interpret the vowels they hear. One possibility is that this grid is their own vowel system and that each vowel produced by a speaker is heard as if it were produced by the listener. At the other extreme lies the hypothesis of a pandialectal grammar, comprising all of the vowel systems that the listener has heard and interpreted (Bailey 1972). Such overall constructs may be the result of interdialectal experience or of a general understanding of what changes are possible or likely to occur. To the extent that such a pandialectal competence exists, sound changes may not interfere seriously with communication across communities. Within a given speech community, we may ask whether all of its members shift their reference grids to include the most recent changes, or whether only those who are participating in the change do so.

3.2 Replicating the Peterson–Barney Experiment

Given the lack of definition of the Peterson–Barney data in regard to dialect differences, the CDC project replicated this experiment with speakers and judges from the three identified dialect areas. This was largely the work of Sharon Ash, and much of the analysis given here is drawn from Ash (1988). Instead of the ten /h_d/ words of the Peterson–Barney framework, fourteen vowels were selected in the /k_d/ environment:

Short		Front upgliding		Back upgliding		Ingliding	
/i/	*kid*	/iy/	*keyed*				
/e/	*Ked*	/ey/	*cade*				
/æ/	*cad*	/ay/	*kide*	/aw/	*cowed*		
/o/	*cod*	/oy/	*koid*	/ow/	*code*	/oh/	*cawed*
/ʌ/	*cud*						
/u/	*could*			/uw/	*cooed*		

Though this framework introduced three non-words (*cade*, *kide*, *koid*) and one trade name (*Ked*), it had the advantage of using the established words *cooed* and *cawed* where Peterson and Barney used *who'd* and *hawed*.

In preliminary work in Chicago and Birmingham, a number of students at the host universities were recorded reading the list of fourteen words. All tape recording was done in a quiet room, using a Nagra IV-S open reel tape recorder at 7 1/2 ips and a Sennheiser 415 directional microphone. Of those recorded in Chicago and Birmingham, the two speakers who were most advanced in the sound changes under study were selected for the test stimuli. In Philadelphia, two speakers were selected from the LCV Neighborhood Study carried out in the 1970s (Volume 2).

Figure 3.1 shows the F1 and F2 positions of the six vowels involved in the Northern Cities Shift – /i, e, æ, o, ʌ, oh/ – as pronounced by the six speakers.[3] Given the formal character of word-list pronunciation with a high degree of attention to speech, it is a matter of interest whether the extreme rotations of the NCS would be reflected in these tokens. The figure shows that this is in fact the case. The raising and fronting of Chicago /æ/ is represented by the location of *Ccad1*, *Ccad2*, which appear at a level with the mid and high vowels of other dialects. The fronting of Chicago /o/ is evident in the approximation of *Ccod1* with *Pcad2* and of *Ccod2* with *Pcad1*. The lowering and backing of Chicago /e/ is reflected in the positions of *Cked1* and *Cked2*. The latest stage of the NCS, the backing of /ʌ/, does not appear in the controlled utterances of Figure 3.1.

Subjects for the experiment were drawn from class groups recruited at each of the selected sites. The test words were presented in dialect sets, and the twenty-eight words in each set were presented in random order. The randomized sets of words were copied onto a Sony WM-D6C cassette tape recorder for playback on the same recorder through a Nagra DSM loudspeaker. Answer sheets were prepared with the fourteen words printed at the top. These words were first read to the subjects by Ash, with the admonition that the reading represented her own speech and might differ from the listeners' speech or from that of the speakers who were recorded on the test tape. The listeners were then asked to write, for each item, the word they believed was being pronounced, using the spellings given at the top of the answer sheet.

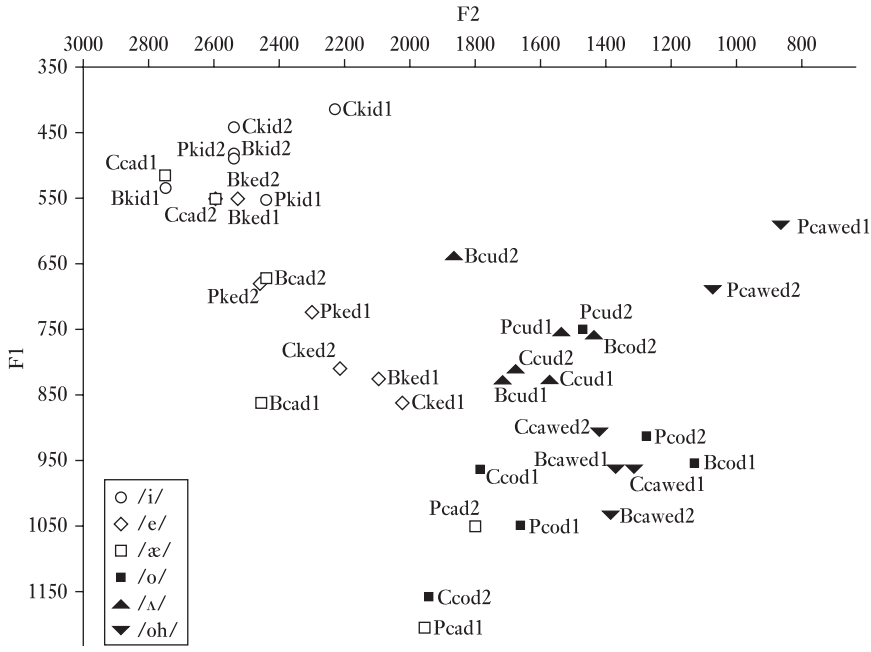

Figure 3.1 Vowel nuclei of the stimuli in the Peterson–Barney replication for *kid*, *ked*, *cad*, *cod*, *cud*, *cawed*. Initial consonant of vowel label: P = Philadelphia, C = Chicago, B = Birmingham

Table 3.1 Percent correct vowel identifications by city of speakers and listeners in the Peterson–Barney replication

	Speakers			
	Philadelphia	Chicago	Birmingham	All
Listeners	N = 27	N = 25	N = 42	N = 94
Philadelphia	**89**	77	64	77
Chicago	81	**81**	71	78
Birmingham	77	69	**77**	75
Total	82	76	71	**77**

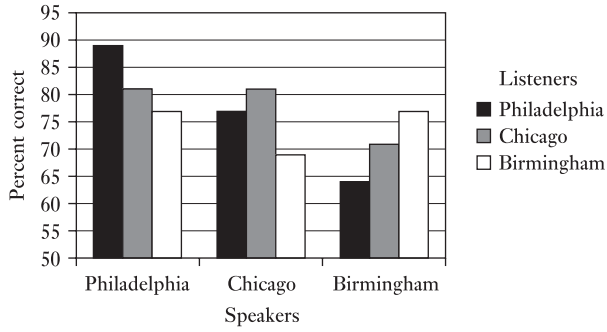

Figure 3.2 Overall correct responses to Peterson–Barney replication

3.3 Overall Success in Identification

The general success in identifying the intended phonemes is shown in Table 3.1 and Figure 3.2. The first comparison with Peterson–Barney (1952) is the percent correct overall. The high figure of 95% correct in the original experiment has been the center of attention ever since, and efforts to develop normalization systems are often judged by the translation of the Peterson–Barney data to reflect that level of success. The overall success rate in the dialect-controlled replication was much lower, only 77%. There were no significant differences in the overall performance of judges from the three cities: all three means were close to the general rate of 77% correct.

Local listeners did better than non-locals, as shown in Table 3.1 by the bold figures in the diagonal of the matrix. This effect held for each city. The local advantage is significant by t-test for all cases, except that the difference between Chicago and Birmingham listeners to the Birmingham speaker (71% to 77%) is not significant. On the whole, this local advantage is only moderate: the best recognition rate in the series, Philadelphians listening to Philadelphians, reaches only 89%, well below the Peterson–Barney level of 95%.

To understand why the success rate was so much lower in this replication, we need to examine the phonetic realization of the stimuli for particular phonemes.

3.4 Responses to the Chicago Speakers

The responses of subjects to the Chicago stimuli are shown in Table 3.2. The numbers in each cell show the percentage of correct identifications; the parentheses

Table 3.2 Percent correct vowel identifications of Chicago speakers in the Peterson–Barney replication (errors > 15% in parentheses)

Vowel Phoneme	Percentage of Correct Responses by Listeners		
	Philadelphia	Chicago	Birmingham
iy	100	96	90
i	98	80 (16 u)	88
ey	72 (22 iy)	68 (18 iy)	52 (30 iy)
e	39 (15 æ, 44 ʌ)	40 (56 ʌ)	55 (36 ʌ)
æ	78	90	60 (18 e)
ay	98	92	86
aw	94	94	88
o	78	90	38 (38 æ, 13 ay)
oh	11 (11 æ, 76 o)	40 (54 o)	8 (83 o)
oy	98	94	80
ow	61 (15 oh)	82	79
u	63 (35 ʌ)	74 (24 ʌ)	71 (23 ʌ)
uw	89	92	85
ʌ	94	96	88
Mean	77	81	69

following show any tendency to misidentify a given phoneme that is greater than 15%. The pattern of errors reflects the rotation of vowels by the NCS, as displayed in the general schema of Figure 1.4 and in the phonetic realization of the experimental stimuli in Figure 3.1.

The raising and fronting of *cad* is shown by a drop from 90% correct for Chicago listeners to 72% in Philadelphia (split among /e/ and /i/ in responses) and to only 60% in Birmingham (largely /e/). The inglide usually heard in fully stressed NCS /æ/ is only partially effective in preserving the distinction between the tense vowel (best represented as /æh/) and the lax front vowels.[4]

The fronted Chicago /o/ was recognized by a high percentage of Chicago listeners (90%), and again by a lower percentage of Philadelphia listeners (78%). Recognition by Birmingham listeners was even lower (38%). An equal number of Birmingham listeners heard Chicago /o/ as /æ/, which is consistent with the equivalence indicated in Figure 3.1.

Chicago /oh/ was generally heard as /o/, even in Chicago, where 54% of the listeners did so. This lowered and fronted phoneme is located between the Philadelphia and Birmingham /o/. The fact that the majority of Philadelphia and Birmingham speakers heard it as /o/ – 76% and 83%, respectively – may be related to the lexical preference for *cod* over *cawed*.

The most extraordinary mismatch between the vowel intended and the vowel identified occurred in the case of /e/. In Figure 3.1, Chicago *ked* is relatively back and low, but quite distinct from the group of /ʌ/ measurements. Nevertheless, the majority of Chicagoans identified this vowel with *cud*, and a sizeable percentage of other listeners did so as well. This must be related to the non-word status of the trade-name *Ked*, a limitation of the experimental design. Nevertheless, it is consistent with the evidence of Chapter 2 and with the Gating experiments (to follow in Chapter 4): the NCS produces considerable confusion of /e/ and /ʌ/.

As a whole, Table 3.2 shows that the vowel rotations of the NCS interfere with the capacity of speakers from other dialects to recognize the vowels produced by Chicagoans.

3.5 Responses to the Birmingham Speakers

Table 3.3 shows the patterns of identifications of the vowels spoken by the residents of Birmingham for judges from the three cities.

The most striking phenomenon is the set of low figures for the recognition of /e/. The great majority hear Birmingham *ked* as *kid.* A glance at Figure 3.1 shows

Table 3.3 Percent correct vowel identifications of Birmingham speakers in the Peterson–Barney replication (errors > 15% in parentheses)

Vowel Phoneme	Percent response by listeners		
	Philadelphia	Chicago	Birmingham
iy	96	94	96
i	89	82	94
ey	69	78	81
e	6 (80 i)	12 (74 i)	25 (69 i)
æ	65	70	73 (21 e)
ay	43 (20 æ, 24 o)	48 (32 o, 16 ʌ)	51 (15 æ, 14 o, 14 ʌ)
aw	70 (22 æ)	78	81
o	39 (11 ay, 33 oh)	52 (38 oh)	61 (20 oh)
oh	37 (44 aw)	48 (28 aw, 12 ow)	74 (15 aw)
oy	93	100	88
ow	74	94	98
u	76 (19 ʌ)	88	88
uw	76	86	94
ʌ	69 (28 u)	60 (36 u)	76 (23 u)
Mean	64	71	77

that this is an accurate perception of the acoustic realization of /e/ in *ked* by both speakers. The symbols *Bked1* and *Bked2* are in the center of the *kid* area and are heard as *kid* by most listeners. Nevertheless, the number of local judges who correctly identified the vowel as /e/ was twice as high as the figure for Chicago and four times as high as in Philadelphia.

The second greatest cause of confusion is in the area of the low back vowels: /o/ in *cod* and /oh/ in *cawed*. Recognition of /o/ ranged from 39% (Philadelphia) to 61% (Birmingham). This is consistent with the fact that the Southern realizations of /o/ and /oh/ are highly skewed from those in other dialects: both have the same low back rounded nucleus, but /oh/ is marked by a back upglide (Figure 1.9; ANAE, Map 18.8). A glance at Figure 3.1 shows that the Birmingham tokens are both well into the [ɔ] region (*Bcawed2* is somewhat centralized). About a third of the nonlocals identified this [ɔ] as /oh/, but a smaller number of the locals did so (20%).

As the pattern of the Southern Back Upglide Shift (Figure 1.9) would predict, the biggest single difference between Birmingham judges and others was in the recognition of the back upgliding *cawed* tokens produced by Birmingham speakers as [kɑod]. The local recognition rate was 74%, versus 48% for Chicago and only 37% for Philadelphia. Most of the Northern judges heard this back upgliding vowel as /aw/ in *cowed*, consistent with the fact that their nucleus for /aw/ is the back [ɑ], used by Birmingham speakers for the vowel of *cawed*.

The most generally recognized feature of Southern speech is the monophthongization of /ay/. Since the eighteen words were heard in blocks, the Southern identity was salient for the Southern section. There is every reason to think that the nonlocal subjects could use any knowledge they had of Southern speech to identify [ka:d] as *kide*. However, less than half did so. The fact that *kide* is not an existing English word undoubtedly played a role here, though it was clearly identified in print and in reading by the experimenter and had high recognition rates in the Chicago version of Table 3.2. In the chapter to follow, we will see that this difficulty in identifying salient features of Southern speech extends to forms extracted from the spontaneous speech of Birmingham speakers. The conclusion is that our subjects do not display the knowledge base necessary to build a pandialectal grammar for cross-dialectal comprehension.

Table 3.3 also reveals considerable difficulty in the identification of Birmingham /ʌ/. This reflects ANAE's finding that /ʌ/ is a relatively back vowel in the North and the Mid-Atlantic states, and relatively front in the Midland and the South, and that this difference is accelerating among younger speakers (ANAE, Ch. 11). There are only small differences among the three groups of judges, and the major error was to hear the intended unrounded vowel as if it were rounded: *cud* as *could*. Since the /ʌ/ ~ /u/ opposition is not salient for many speakers,[5] confusion was not unexpected. But the confusions are reversed in Chicago and Birmingham: Birmingham /ʌ/ has a notable tendency to be taken for /u/, and Chicago /u/ for /ʌ/. This remains to be explained.

3.6 Responses to the Philadelphia Speakers

Table 3.4 gives the percentages of correct responses to the Philadelphia speakers for judges in the three cities. The most striking difference between local and non-local listeners is found in reactions to /æ/ in *cad*. This may seem surprising since Philadelphia does not show tensing and raising of /æ/ (unlike New York City). However, recent studies of Philadelphia report a tendency in apparent time to backing of lax /æ/ (Conn 2005), and the two tokens of *Pcad* in Figure 3.1 are further back than the Birmingham or Chicago versions. Most importantly, the strong fronting of Chicago /o/ leads to the coincidence of Philadelphia *cad* with Chicago *cod*. Both Chicago tokens of *cod* are overlapped with Philadelphia *cad*. As a result, 32% of the Chicago listeners assigned Philadelphia *cad* to *cod*. Almost as many, 28%, heard this as a variant of *kide*. It can be noted here that one of the regular features of the Inland North (Chicago) dialect is the identification of the nuclei of /o/ and /ay/: both are equally fronted.

Birmingham listeners did not have much greater success in identifying Philadelphia /æ/: only 44% of their judgments were correct. Here the majority of the errors assigned the Philadelphia /æ/ to /ay/, understandable in the light of the fact that Birmingham monophthongal /ay/ is shifted to the front, close to Philadelphia /æ/.

Table 3.4 Percent correct vowel identifications of Philadelphia speakers in the Peterson–Barney replication (errors > 15% in parentheses)

Vowel Phoneme	Percentage of correct responses by listeners		
	Philadelphia	Chicago	Birmingham
iy	98	98	93
i	96	92	85
ey	72 (22 iy)	66 (32 iy)	60 (33 iy)
e	76	68	62 (15 ey)
æ	76 (15 o)	32 (28 ay, 32 o)	44 (32 ay)
ay	93	86	82
aw	87	80	82
o	89	88	82
oh	89	82	76
oy	93	88	80
ow	89	70 (18 uw)	68 (30 uw)
u	98	96	95
uw	94	92	81
ʌ	98	92	92
Mean	89	81	77

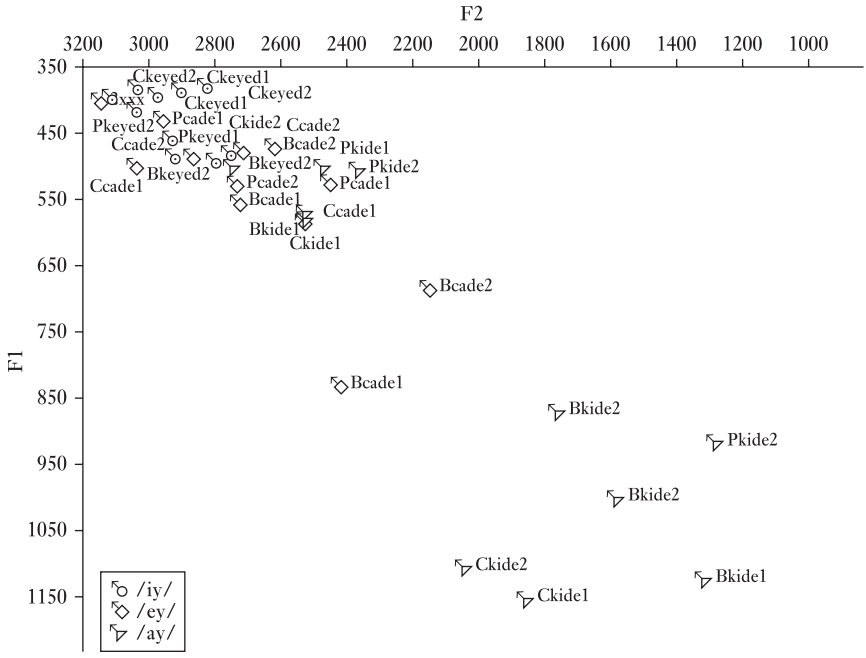

Figure 3.3 Vowel nuclei of the stimuli in the Peterson–Barney replication for front upgliding vowels in *keyed*, *cade* and *kide*. Initial consonant of vowel label: P = Philadelphia, C = Chicago, B = Birmingham

The downward shift of /e/ and /æ/ in Philadelphia also led to difficulty in the interpretation of /e/, which was only 76% correct among local listeners and somewhat less among nonlocal listeners.

One of the new and vigorous changes in Philadelphia is the raising of checked /ey/, overlapping with /iy/ (Volume 2, Chapter 4; Conn 2005). Figure 3.3 shows the F1/F2 positions of *keyed* and *cade*; one token of Philadelphia *cade* is very close to Birmingham *keyed*. As a result, a good 22% of Philadelphians heard their own *cade* as *keyed*, and a full third of the judges from Chicago and Birmingham heard the same.

3.7 Overview

It is generally recognized that the Peterson–Barney experiment would have benefited from closer control of the speakers' dialect. This experiment controls dialect variation within North American English, selecting advanced speakers of the three major

regional dialects. The purpose is to further the inquiry begun in Chapter 2: what are the consequences of ongoing sound change for comprehension within the larger boundaries of the English language? In place of the naturally occurring misunderstandings of Chapter 2, we have the careful reading of a controlled list of syllables. This reduces the chance that the misunderstandings are due to unintended errors of articulation, and also eliminates the effects of varying and unusual contexts. Given the understanding that the fundamental function of the phonemic oppositions such as /æ/ ~ /o/ is to distinguish one word class from another, it must be admitted that, when this function fails, the phonemic system has failed.

In each of the three cities a significant local advantage was found. This reflects an increased likelihood of misunderstanding when residents of Philadelphia are brought into sudden contact with speakers from Chicago. These events may not bulk large against the sum total of communications in everyday life. It is often assumed that, if such cross-dialectal contacts are frequent and habitual, listeners will adjust their perceptual and interpretive systems so as to lower the rate of misunderstanding. The repeated instances of *copy* ~ *coffee* confusion in items (30)–(39) in Chapter 2 suggest that this adjustment may not happen as readily as we would like to think.

In each particular case, the local advantage was explained through the match or mismatch of the phonetic tokens produced by the six speakers, and the mismatch was in all cases explained by the opposing direction of the chain shifts, defined in Chapter 1. But the effect of sound change on comprehension appears to be even larger when we consider the error rates of the local listeners.

56% of the Chicago listeners heard Chicago /e/ as /ʌ/
54% of the Chicago listeners heard Chicago /oh/ as /o/
74% of the Birmingham listeners heard Birmingham /e/ as /i/
48% of the Birmingham listeners heard Birmingham /ay/ as /o/ or /ʌ/
40% of the Birmingham listeners heard Birmingham /oh/ as /aw/ or /ow/
22% of the Philadelphia listeners heard Philadelphia /ey/ as /iy/
15% of the Philadelphia listeners heard Philadelphia /æ/ as /o/.

These figures are lower for Philadelphia than for Birmingham and Chicago. But Philadelphians, like the others, fall short of the expected mark in interpreting the speech that they hear around them in everyday life. It is important to bear in mind that the persons who made the recordings were from the same socioeconomic and age groups as those who served as judges.[6] The results of this chapter agree with the findings of Chapter 2 on the extent of cross-dialectal miscomprehension. These results go further, showing that sound change reduces comprehension within the speech community as well as across communities.