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A sociolinguistic perspective on sociophonetic research

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Abstract

The four papers in this issue of the journal are jointly focused on two distinct themes: sociophonetics—the study of speakers and listeners' sensitivity to the social context in which language is produced and perceived—and exemplar theory, as a way of explaining this behavior. In these comments, I will try to relate the findings in the first area to the field of sociolinguistics, and then relate the discussion of exemplar theory to recent studies of change in progress.

1. Sociophonetics and sociolinguistics

The term "sociolinguistics" is applied to a wide range of studies that relate language and society. The quantitative analysis of linguistic change and variation began in the mid-1960s, and has steadily expanded over the past four decades. From the outset, acoustic analysis played a major role in this enterprise. The first uses of acoustic analysis in sociolinguistics were based on the early conclusions of Haskins phoneticians that the first two formants provided most of the information to discriminate English vowels (Cooper, Delattre, Liberman, Borst, & Gerstman, 1952; Delattre, Liberman, Cooper, & Gerstman, 1952; Liberman, 1957). Sound changes in progress were located in a number of speech communities (Labov, Yaeger, & Steiner, 1972; Lennig, 1978). Without taking into account such demonstrated matters as spectral tilt, the dependence of F1 and F2 on F0, the influence of F3 and F4, it was possible to trace the progress of sound changes across many communities with detailed studies of the vowel systems of hundreds of speakers (Labov, 1991; Fridland, 1999; Thomas, 2001). This made it possible to carry out multivariate analyses with formant values as the dependent variables, and age, gender and social class as independent variables, controlling simultaneously for the full range of phonetic environments. As the technology of formant analysis advanced, the quantity of data that could be processed expanded to support a more general theory of sound change and the general principles that govern change across the continent of North America (Labov, Ash, & Boberg, 2006). This sociolinguistic exploitation of early phonetic technology was engaged primarily in the study of speech production; only recently can one find a parallel advance in dimensions of phonetic analysis or studies of speech perception.[1]

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[1]At the 34th annual meeting of the Conference on New Ways of Analyzing Variation, there were some 40 papers that utilized acoustic analysis, with a significant number dealing with speech perception.

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The papers of this volume give a strong impetus to the subfield of "sociophonetics" with their joint focus on social context and controlled experimentation.[2] There is no doubt that the range of experimental methods and statistical analyses go considerably beyond those that we find in current sociolinguistic practice.[3] The use of the term *sociophonetics* suggests the possibility of a field of research emerging as a separate discipline, with its own questions, techniques and standards of proof. Yet this may be a distraction from the main point: the conjoining of two streams of research that have hitherto been separated. Certainly these sociophonetic studies are not disjoined from the broader field of sociolinguistics. Two of the contributions are from research centers that have played a major role in recent discussions in sociolinguistics. The group of Foulkes, Docherty and Watt has produced a number of studies of sociolinguistic patterns of Tyneside and the early stages of the acquisition of sociolinguistic variables (Docherty, Foulkes, Watt, & Tillotson, 2003, Docherty et al., 1997, Watt, 2000). Hay, Warren and Drager's work emerges from the ONZE project (Gordon & Maclagan, 1989; Maclagan, Gordon, & Lewis, 1999), which traced changes in New Zealand English over the past century with the help of the fortunate discovery of an archive of early recordings. The findings of all four studies articulate closely with sociolinguistic work on class, gender and age stratification, developing the perceptual mechanisms that are needed to account for the acquisition and transmission of the social differentiation of language.

1.1. Real time change among adults

Harrington's investigation of changes in the Queen's English relates closely to a large body of current re-studies of linguistic variables in real time. A number of investigators have pursued the question of what linguistic changes can and do take place across the lifespan. The first studies of change in progress searched for real time evidence to calibrate inferences on change drawn from age distributions, or apparent time, but the earlier studies were only roughly comparable (Labov, 1963, 1966).[4] The most highly valued comparisons for this purpose are like Harrington's study of Queen Elizabeth: re-recordings of the same individual after a period of time. Since Harrington's references to the earlier literature do not include their findings, a summary here may underline the importance of his result.

In their study of Copenhagen Danish, Brink and Lund obtained recordings of the same speakers as much as 50 years apart, and reported no significant change in the Copenhagen variables (1975). In Philadelphia, a group of speakers over 50 at the time of first interviewing were recorded telling the same stories to the same interviewers after a period of 17 years. Acoustic analyses showed no detectable changes in the use of ten Philadelphia vowels involved in change in progress (Labov & Auger, 1998). In Montreal, 60 of 120 speakers who were first interviewed in 1971 were re-interviewed in 1984. The apparent time studies of 1971 showed a substantial shift of apical to uvular /r/, and the comparable figures of 1984 indicated that the trend was continuing. Sankoff's study of 32 individuals (2002) showed that only nine made a significant increase in their frequency of uvular /r/. None of these were over 50 in the earlier study.[5] In her review of apparent time and real time studies, Sankoff (in press) concludes:

> as they age, people register lesser differences from their earlier selves than does the community over the same time interval…those adult speakers who change are (a) in the minority; (b) concentrated in the younger-age cohorts of adults and (c) make less significant advances than the community as a whole.

The significance of Harrington's result is therefore not due to the paucity of other longitudinal re-studies, but rests on his strengthening the case for adult change rather than stability. He has shown with meticulous care that one individual—who might have been expected to be the most resistant to changes in the community

[2]While Harrington's paper is a study of speech production, it makes use of a "natural experiment" to make a controlled comparison of speech across time.

[3]As for example, Harrington's use of the second coefficient of cosine transformations to register differences of curvature in the formant trajectories of /i/ and /iy/.

[4]Harrington's statement that studies in apparent time assumed adult stability is not quite correct, since all such studies treated this as an empirical question to be determined by further work.

[5]The shift from apical to uvular /r/ does not involve the possibility of changes in vocal tract length or posture, but is a more discrete shift of articulatory gesture.

pattern—did in fact absorb community change in her own speech. This change is clearly not the physical result of aging, since schwa has shifted if anything in the other direction.

Harrington suggests that reason the change took place in F1 but not in F2 may be that raising may have been an earlier stage of the change. If so, this agrees with the results of Sankoff's conclusion that stability is more characteristic of speakers over 50 than younger adults. If the data permit, it would be illuminating to examine the relative change in the Queen's vowels in the earlier half of the period—1950s to 1970s as compared to the later half.

One may also want to consider the finding that F2 is consistently correlated more highly with social factors than F1. The Philadelphia study of the raising and fronting of /æ/ in *man, bad, bath,* etc., /aw/ in *down, out, now,* etc. and checked /ey/ in *made, pain*, etc., showed that in each case social class, gender and ethnicity coefficients were stronger and more consistent for F2 than for F1 (Labov, 2001). If this holds for unstressed lax /i/ in Great Britain, the Queen may have been responding to a stronger social class association of raised F2 than lowered F1.

Strengthening the case for the sensitivity of (at least some young) adults to community change then underlines the problem of explaining why most adults do not change. The contrast between adults and children was brought to the fore in Payne's study of 34 families in King of Prussia, a middle class suburb of Philadelphia in which about 50% of the population came from other dialect areas (1976, 1980; Labov, 2001). Children who arrived in Philadelphia under the age of 9 showed rapid acquisition of all the major Philadelphia sound changes. But adults born out-of-state departed very little from the phonetic patterns of their formative years, with only a few occurrences of the characteristic Philadelphia vowels.

1.2. Gender and the normalization problem

Johnson approaches gender differentiation by rejecting the null hypothesis that male/female differences can be "lawfully derived from typical vocal tract length differences" and concludes that such differences are the product of socially motivated and largely arbitrary choices. The production data that he presents for cross-linguistic variation agrees with the conclusions of a very large number of sociolinguistic studies of spontaneous speech communities (e.g., Labov, 1966, 2001; Trudgill, 1974; Cedergren, 1973; Eckert, 1999). But in rejecting this null hypothesis, Johnson goes further than most sociolinguists:

> the arbitrariness of gender differentiation in speech calls into question "normalization" and the unitary abstract phonetic representations usually assumed by normalization procedures.

Though I may be over-interpreting the scare quotes here, it seems to me that Johnson is arguing that listeners are not able to directly compare men's and women's speech on the same phonetic and phonological grid, to say for example, that a particular woman's production of a tensed short-*a* in *mad* is higher and fronter than a particular man's production.[6] Rather, he might argue, a listener has first to compare the woman's production to his memories of how other women speak, and then relate that difference to a comparison of the man's production to his memories of men's speech, before concluding that the woman said [meːəd] while the man said [mɛːd] in terms of unitary abstract phonetic representations. Johnson then develops this position with Strand's experiment on the perception of speaker differences (2000), which shows that the perception of speech is enhanced for voices with stereotypical male/female characteristics and inhibited for voices that are deviant in this respect.

Most phonetic approaches to normalization looked for a way of eliminating the gender differences in such data sets as Peterson-Barney (1952). If vocal tract length differences were the main cause, then a single scaling constant should do the job. But it was early demonstrated that these gender differences were not linear (Gerstman, 1967). This produced a real problem for those sociolinguists who wanted to use acoustic measures in comparing the productions of men and women. Supposing that gender differences are a mixture of the effects of vocal tract length differences and social factors, how could one separate the two types of influence, and arrive at a scaling factor that eliminated only the differences due to vocal tract length without removing

[6]The same issue applies even more strongly to a comparison of pre-adolescent productions with those of adults.

the effect of social factors? If women were leading in a given sound change, how could one demonstrate this with acoustic measurements?

The approach that we took in the study of linguistic change and variation in Philadelphia was to begin with a difference that was so large and robust that it could easily be registered with impressionistic phonetics and did not involve differences in vocal tract length. The social stratification of the tensing (raising and fronting) of /æ/ in Philadelphia provided such a test case. There are two main types of words that undergo this sound change. The allophone æhS is the group of short-*a* words in syllables closed with voiceless fricatives as codas: *fast, past, half, bath,* etc. The allophone æhN indicates short-*a* words in syllables closed with front nasal codas: *ham, man, stand,* etc. The degree of tensing is best measured by the increase of F2. This is the most highly stratified sociolinguistic variable in the Philadelphia vowel system. Impressionistic studies independent of acoustic measurement show an inverse monotonic function of both height and fronting by social class. Three methods of normalization were tested to see which would best eliminate from the acoustic data the effects due to differences in vocal tract length without eliminating the social stratification. (1) The vocal tract length method which uses the third formant of low vowels as a scaling factor to estimate vocal tract length (Nordström-Lindblom, 1975). (2) The log mean method (Nearey, 1977), which uses a scaling factor derived by comparing the population log mean for all formants for all vowels to the log mean of each individual. (3) A six-parameter regression algorithm designed to produce the maximum clustering and reduction of between-group differences (Sankoff, Shorrock, & McKay, 1974). The first two are uniform scaling methods; the third goes beyond uniform scaling.

Fig. 1a shows the effect of these three methods in reducing the age and sex differences that are correlated with vocal tract length, using three separate vertical axes. One registers the standard deviation (S.D.). The two uniform scaling methods show a sharp reduction in S.D. for both allophones (dark triangles) and the six-parameter method considerably more. The other two axes show the size of the age and sex coefficients in a multiple regression analysis of F2 for both allophones. The significance of these two coefficients is shown by the size of the hexagonal symbols. The two uniform scaling methods reduce these coefficients without eliminating them, but the six-parameter regression eliminates them entirely. It seems likely that there are residual differences in age and gender use of these variables which are not due to vocal tract length differences, as Johnson argues. However, we cannot be sure from this diagram if this is so and the uniform scaling methods are preserving it, or whether the perceived and age and sex differences are in fact entirely due to vocal tract length differences. To decide this issue, we have to turn to Fig. 1b.

Fig. 1b shows the effect of normalization on regression coefficients for the F2 of the two allophones for six socioeconomic groups. The unnormalized data shows no significant social effects. Both the vocal tract length and log mean normalizations show social stratification, with the sharpest effects for the log mean method. The lower working class (0–5) is the residual group for comparison. The middle working class (6–8) is not significantly different. The upper working class (9–10) shows a significant negative coefficient only for the prenasal allophone. The lower middle class (11–12), upper middle class (13–15) and upper class (16) show increasingly large and robust negative coefficients. However, the six-parameter regression method eliminates all social stratification effects.

It appears that both the vowel tract length and log mean normalizations are in the desired range of clustering operations, minimizing gender differences due to vocal tract length and preserving those social differences that were not due to vocal tract length. The log mean normalization was therefore adopted for further analysis of sound change in Philadelphia. Though neither scaling method may correspond to the actual normalizing mechanism used by listeners, they indicate that it is possible to make a reasonable estimate of how the variance of acoustic parameters of vowels is to be apportioned. It was then possible to determine that for two of the new and vigorous changes, women were one generation ahead of men, while for the third, men were in advance of women. Gender differences were then related to the asymmetrical character of language transmission (Labov, 1990), and similar procedures have since been proved useful for many other sociolinguistic studies.[7] The log mean normalization was applied to 439 subjects of the Atlas of North

[7]The rate of change per generation appears as "age × 25 years", with a beta coefficient of −35.7, almost exactly the coefficient for Female at 38.03. Thus women differ from men by the difference predicted for one (younger) generation.

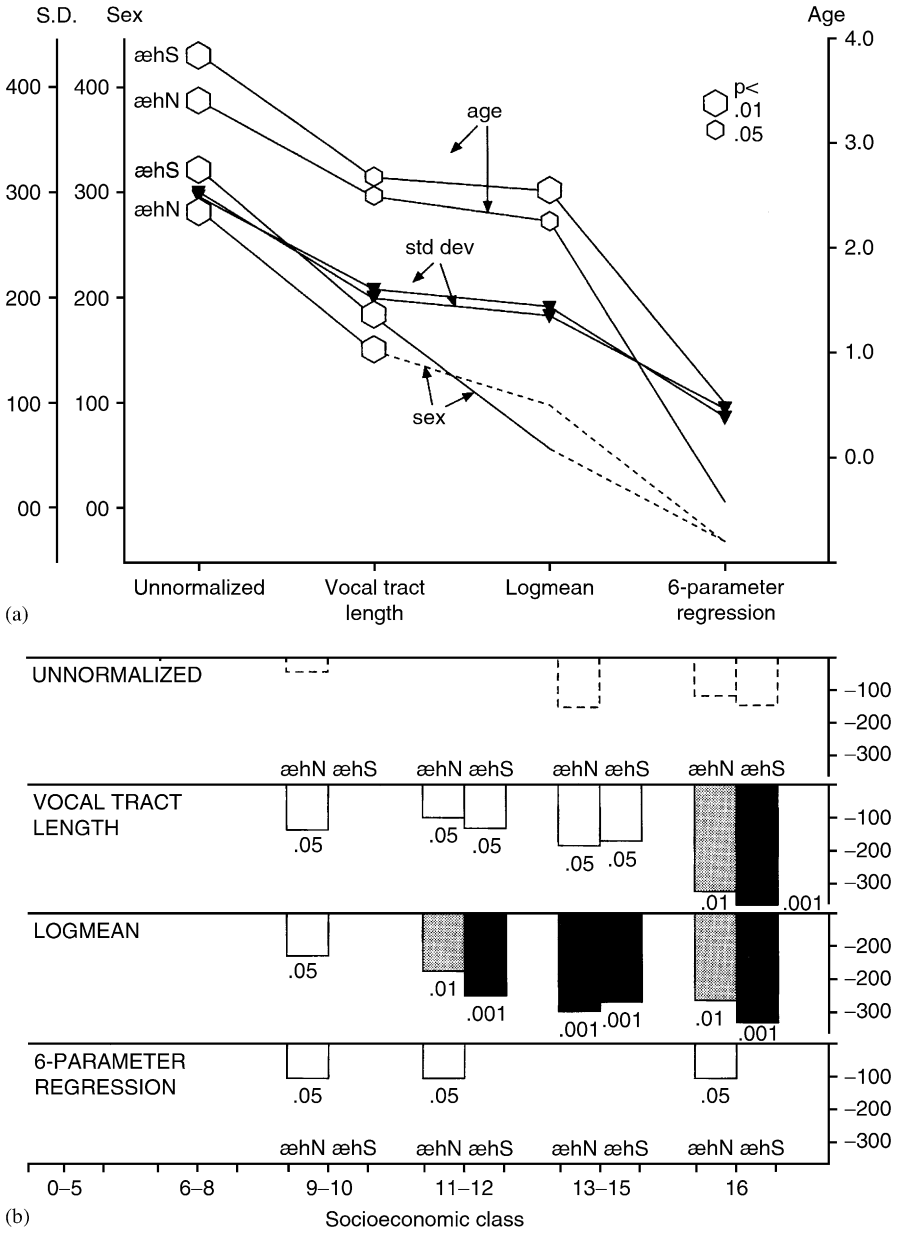

Fig. 1. (a) Effect of three normalization methods on regression coefficients for age, sex and standard deviations of the second formant of two allophones of /æ/ in the Philadelphia Neighborhood study ($N = 112$). æhN = tensed /æ/ before nasal consonants. æhS = tensed /æ/ before voiceless fricatives. *Source*: Labov (2001, Chapter 5). (b) Effect of three normalization methods on the regression coefficients for soecioeconomic class for the second formant of two age coefficients in the Philadelphia Neighborhood study [$N = 112$]. Numbers below bars show probabilities based on *t*-test for each coefficient. Socioeconomic class scale: 0–5 lower class; 6–8 middle working class; 9–10 upper working class; 11–12 lower middle class; 13–15 upper middle class; 16 upper class. *Source*: Labov (2001, Chapter 5).

American English (Labov et al., 2006) to produce regression analyses like that of Table 1, where it can be seen that women are one full generation ahead of men in the fronting of /ow/.

Adank (2003) tested 12 different methods of normalization, following the same logic of reducing the effect of vowel tract differences but preserving regional differences. In this case, the social information to be preserved was well-described regional differentiation of Dutch dialects. The log mean normalization method was found to be the second best by these criteria, surpassed only by Lobanov's *z*-transformation (1971).

Table 1
Multiple regression coefficients for F2 of /ow/. in North America

Variable	Coefficient	prob
Constant	1328.06	⩽0.0001
Social		
Age∗25	−35.70	⩽0.0001
Female	38.03	⩽0.0001
City size (millions)	−9.14	⩽0.0001
Frequency (*Brown*)	0.01	0.5088
Phonetic		
Lateral coda	−245.10	⩽0.0001
Nasal coda	−98.37	⩽0.0001
No coda	66.84	⩽0.0001
Coronal onset	59.92	⩽0.0001
Labial onset	−50.56	⩽0.0001
Onset voiced velar	85.91	0.0001
Following syllables	−44.69	⩽0.0001
Onset /h/ coda nasal	−134.60	⩽0.0001
Lexical		
no	62.73	0.0092

Split half (even). $N = 3927$, r^2 (adj) = 34.8%.

1.3. Near-mergers and discrimination

The experiment on the perception of the *NEAR/SQUARE* opposition by Hay, Warren and Drager [HWD] follows a long series of studies of this ongoing merger in New Zealand. There has been considerable disagreement about the direction and mechanism of the merger, but in the light of the many results summarized by the authors, it seems clear that at least in the South Island, the merger is steadily progressing by the shift of the ingliding mid-vowels to high position. The main results of the experiment are both surprising and convincing. Subjects are influenced in their perception of phonemic category membership by the inferred age and social class of the speakers. This is a result of great interest to many sociolinguists who have been following the correlations between age, social class and the progress of a change, and searching for the links by which these social factors determine the course of change. There is no great distance between saying that speakers associate phonemic merger with younger speakers and saying that they are socially motivated to follow the path of younger speakers.[8]

This New Zealand merger appears to show a higher degree of social awareness than most mergers. It contrasts sharply with the sudden collapse of the *cot/caught* distinction of long and short open /o/, as studied in Eastern Pennsylvania by Herold (1990, 1997). In that merger the tokens of both classes were reorganized to occupy a phonetic space equal to that of the two former distinct classes combined, as opposed to the unidirectional shift of the mid-vowel to high position in New Zealand. The *cot/caught* merger of long and short open /o/ has not so far been found to exhibit the effects of frequency or any other lexical differentiation, and it is rarely the subject of social comment. In this respect, the New Zealand merger of *fear/fair, beer/bear,* etc. may be closer to the current reversal of the same word classes in Charleston, South Carolina (Baranowski, 2001). Unlike the *cot/caught* merger, the Charleston *fear/fair* merger has been the subject of considerable social comment, and it seems unlikely that the reversal of the merger could be accomplished without considerable social pressure.

The HWD experiment shows an extraordinary number of main effects (HWD Tables 7,8) and a number of significant interactions. Not all of these were expected, and the authors show both honesty and ingenuity in

[8]The steady forward movement of the unmerger or any other sound change may then be driven by the *ratchet principle* (Lieberson, 2000), which automatically favors variants that are seen as "in fashion" as opposed to those that are "out of fashion."

wrestling with them. It is particularly surprising to find that the subjects with the greatest tendency to merger show a higher error rate if they worked with the experimenter from the US rather than from New Zealand. One might have expected the opposite. The authors argue that since the US speaker's NEAR and SQUARE tokens show a greater phonetic distance than the New Zealander's vowels, the subjects may have been influenced to hear the experimental (New Zealand) tokens as less distinct. This is of course post hoc and might require elaborate further experiments for confirmation. Yet I find some support from experiments on cross-dialectal comprehension that we carried out in Chicago, Birmingham and Philadelphia, to test people's ability to identify advanced tokens of sound changes in progress (Labov & Ash, 1997). Subjects heard these tokens as isolated words, in phrases and in sentences. In listening to their own dialects, high school students showed higher percentages of correct identification of isolated words than college students. For example, one Chicago token was a strongly fronted realization of the word *socks,* to the extent that almost all outsiders heard the word as *sacks* in isolation.[9] Chicago high school students showed 89% correct identification, but Chicago college students only 62%. We concluded that the college students were influenced by their experience in hearing a wider range of speakers governed by other norms, and this greater experience prevented them from recognizing their own speech patterns.[10] A parallel mechanism may be operating in the very short exposure of New Zealand subjects to the outsider's experimental instructions.

Among other surprising results of the HWD experiment is the fact that speakers with highly merged systems—Pillai scores close to zero—showed considerable ability to recognize the class membership of SQUARE tokens. The right hand side of HWD Fig. 4 shows a speaker who is obviously and completely merged. Yet the estimated mean of subjects in this range is 70% correct identification of the SQUARE class. This and other characteristics of the subjects show a striking similarity to the cases of "near-merger" that have been located and analyzed over the past four decades (Di Paolo, 1988; Di Paolo & Faber, 1990; Labov, 1975, 1994; Labov et al., 1972; Kontra, 1993). In these situations, subjects consistently report that two classes sound "the same", even though they make consistent and sigificant differences in speech production. In all such cases, we observe great individual variation, as in New Zealand.

One case that we have studied in some detail is the Philadelphia near-merger of /e/ and /ʌ/ before intervocalic /r/ in *ferry* vs. *furry*, *merry* vs. *Murray,* etc.(Labov, Karan, & Miller, 1991). We recently designed experiments to distinguish subjects' ability to perceive the difference on a psycho-acoustic basis from the tendency to label the classes as "the same". Among the tests we included a discrimination experiment in which subjects heard two pairs of words in succession, and were asked to judge which of the pairs were different and which were the same. The pairs were tokens of the words *ferry* resynthesized along the *ferry*/*furry* continuum with 100 Hz increments of F2 from 700 to 1600 Hz. Subjects were exposed to a randomized series of pairs which differed by 300, 200 and 100 Hz in all possible orders. Fig. 2 shows the responses of 21 Philadelphians and 14 subjects from outside of the Philadelphia area. The outsiders show a classic Weberian linear relationship between discrimination and phonetic distance. The Philadelphians show much weaker discrimination at the 300 and 200 Hz distances, but are not significantly different from others at 100 Hz. For such pairs, most subjects were subjectively convinced that the pairs were identical, but were asked to make a forced choice. The 70% success rate is identical to that of the New Zealanders with the greatest tendency to merger.

On the right of Fig. 2 are shown the results of three commutation tests in which subjects are asked to label a randomized series of the two classes, from their own speech, from that of a near-merged speaker, and from an outside speaker with a clear distinction. The ability of Philadelphians to label their own tokens is about equal to their performance on the 100 Hz discrimination test, and equivalent to their labeling of a near-merged speaker; but their ability to label a clear distinction does not rise above 78%.

There is a great deal of individual variation among the Philadelphians, but very little among the outsiders. The 21 Philadelphians include eight who behave like outsiders, six with lowered levels of discrimination, and seven who are radically different. For this last group, the discrimination task becomes easier as the distance

[9]This is the second step in the Northern Cities Shift, following the general fronting and raising of all short-*a* words to mid and high position.

[10]The experimental tokens were drawn from interviews with members of the same freshman class at the University of Illinois, Chicago Circle, who served as judges in the experiment.

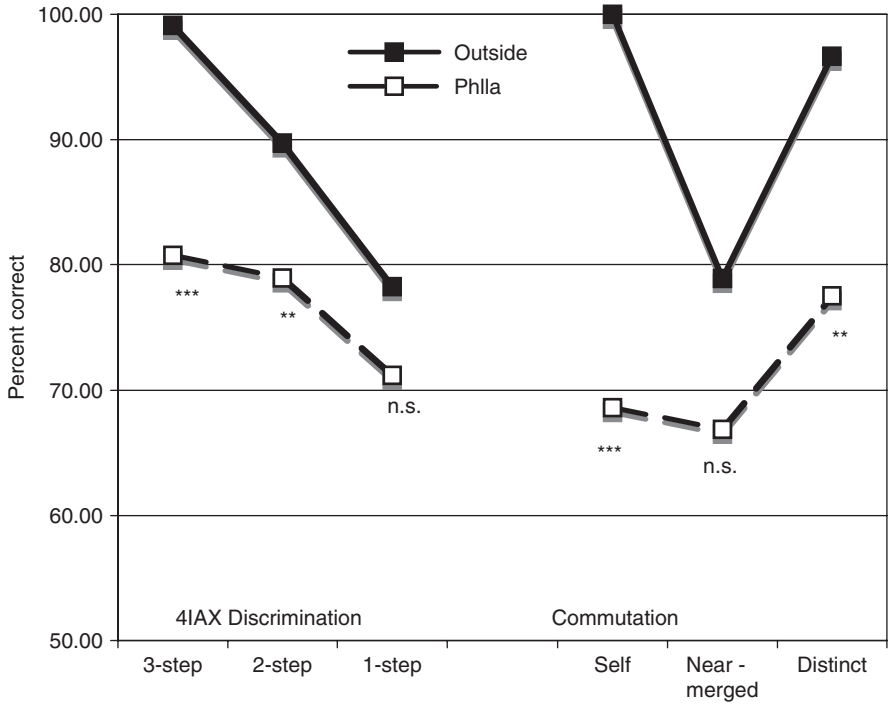

Fig. 2. Discrimination and categorization performance for subjects born and raised in Philadelphia ($N = 21$) and those from outside of the city ($N = 15$). Significance of differences between Philadelphians and Outsiders: ***$p < .001$; **$p < .01$; n.s. $p > .05$.

diminishes, until they converge with others at the 70% level for the one-step discrimination: that is, they do better when they are convinced that the pairs are identical. In this respect they resemble even more closely the New Zealanders. As HWD remark:

> …the merged participants can still do very well at this task (despite the fact that many report they are guessing).

It is possible that some New Zealand subjects may also have a disjunction between their ability to discriminate and their ability to label: that the psychoacoustic ability to discriminate deteriorates when subjects are asked to label phonemic categories that are for them identical at a higher level of analysis.

1.4. The acquisition of sociophonetics variants

Sections 1–3 of Foulkes and Docherty [FD] provide an overview of sociophonetics findings, methods and goals that would be difficult to improve on. The most noteworthy contribution of the authors is to our understanding of the acquisition of linguistic variation in the earliest stages. The first work on mothers' interaction with children emphasized the invariance of the end result of first language learning and limited the effect of mothers' behavior to the clarity of presentation of the forms involved. The general conclusion was that almost any type of interaction would trigger the innate learning mechanism equally well (Newport, Gleitman, & Gleitman, 1977). But the Newcastle/York group has demonstrated specific shaping of linguistic variants by mothers, with differential modeling of phonetic production for boys and girls. Foulkes, Docherty and Watt have had the advantage of working with consonantal features that are not involved in the physical changes dependent on the lengthening of the vocal tract. But more important is the way in which they have molded the design of phonetic research to fit the critical dimensions of the speech community.

One can also recognize, throughout the FD exposition, a note of insistence that social factors *should* be taken into account in phonetic description. I would like to reflect on the nature of the justification for this position. The authors state (p. 26) that ''No natural human utterance offers information without indexing

some social factor.'' This must be so, even in the trivial sense that everything said is spoken by someone. But it does not follow automatically that all such indexing should be described. One might argue that if not, our descriptions will be incomplete; but surely all description is incomplete. We do not, or cannot hope to describe all the ways in which we recognize individual sounds and voices. No matter how narrowly we code variation, there will still remain a residue of free variation. Some further justification for the description of variation is required; otherwise there will be no stop to the enterprise and we will be plunged into an endless pursuit of detail.

It may be helpful to consider separately the four types of segmental variation that FD cite from Wells at the outset. In the first type, the fundamental structure of the system varies, and an incomplete description of the phonology would be simply a wrong description. Thus the HWD study in this volume needs no further justification since it deals with variation in the structure of categories. Within that structure, it is usually the grossest type of allophonic variation that demands our attention, in cases where no invariant label will allow others to recognize the phenomena. This is certainly the case with the range of consonantal variation studied by FD, with variants ranging from laryngealized lenited stops to aspirated plosives. To ignore the social distribution of the laryngealized forms will be grossly misleading when use ranges from 33% to 95% (FD Fig. 3).

Still, we cannot avoid the question, where does the study of variation stop? It seems to me that the justification for any study is not that there is work left undone, but that there is something missing in the puzzle. The linguistic problems that most clearly demand attention are the cases where the facts do not add up, leaving us with configurations that we do not really understand. The problem of accounting for language acquisition, with its extraordinary speed and accuracy, remains to be solved. We still do not know how people retrieve words with the dazzling speed and accuracy that they achieve. It may be that these problems demand the study of social variation; I am not sure that they do. For me, the largest questions that require the analysis of social variation are the problems of language change: how such changes are initiated, how they are transmitted across generations, what drives them forward, how they reach completion. The papers in this volume make important contributions to these questions. I am not sure that they demonstrate to colleagues engaged in more abstract analyses that their search for the invariant core of the language faculty will fail if they do not take social variation into account. This is not to minimize the importance of social variation; the following section will attempt to define more precisely the limits of the interface between language and society.

2. Exemplar theory and the role of words

In the second part of these comments I would like to reflect on one aspect of exemplar theory that plays a major role in all four papers. I take as a point of departure the model developed by Pierrehumbert in ''Word-specfic phonetics'' (2002), which is referred to in three of the four papers. Pierrehumbert begins by characterizing the accepted ''feed-forward'' model:

> In fluent, mature speakers, the phonetic implementation system is a modular, feed-forward system, reflecting its nature as an extremely practiced and automatic behavior…The model is feedforward because no arrows go backwards, from articulatory to phonological encoding, or from the phonological encoding to the lexical level. It is modular because no lexeme information can influence the phonetic implementation directly, bypassing the level of phonological buffering.

Pierrehumbert then opposes the exemplar model to the feedforward model in that phonetic implementation is accomplished by probabilistic reference to regions of exemplar space, populated with remembered words. In this model, the influence of exemplars on production and perception is necessarily dependent on their token frequency, so that word frequency strongly determines phonetic output. Evidence is drawn the from studies of leniting historical change summarized in Bybee and Hopper (2001) (see also Bybee, 2002). Pierrehumbert argues explicitly that the model is not confined to leniting changes:

> Obviously, this treatment is not confined to lenition; any systematic bias on the allophonic outcome would incrementally impact high frequency words at a greater rate than low frequency words. In short the model

is applicable to any Neogrammarian sound change, by which I mean sound changes which get started in the phonetic implementation and eventually sweep through the vocabulary.

The model then applies not only to the vowel shifts described by Harrington and HWD, but to all of the vowel shifts and mergers that we have been studying in the Atlas of North American English. The role of the lexicon here is particularly interesting to me. Since Wang and his associates first re-stated and reinvigorated the case for lexical diffusion as the basic mechanism of sound change. I have been wrestling with the problem of when and how sound changes proceed with the word as the unit of change, and when they proceed with the phoneme as the basic unit (Labov, 1981, 1994). Pierrehumbert collapses this opposition by portraying Neogrammarian change as regular because it eventually affects the entire vocabulary, but lexical in its implementation.[11] This of course was not the understanding of the Neogrammarians, who saw sound change as a purely phonetic process, blind to both meaning and lexical identity (Osthoff & Brugmann, 1976; Saussure, 1959; Bloomfield, 1933). In what follows, I will use "regular sound change" to refer to the original Neogrammarian view of the process.[12]

There is little room for doubt that some sound changes proceed by lexical diffusion. The tensing of short-*a* in the Mid-Atlantic States, which has been studied in fine detail over the past 70 years, is a textbook case (Ferguson, 1990; Labov, 1989; Trager 1930). My best present estimate is that lexical diffusion occurs with changes from one abstract category to another (shortenings and lengthening), in late stages of a change that has risen above the level of social awareness (as in stigmatized stereotypes), and in changes that intersect with morphological paradigms (as in English open syllable lengthening).[13] In this volume, the HWD paper provides a convincing case for the influence of lexical exemplars on category judgments. The New Zealanders' performance in identifying *fear* and *fair*, etc. was clearly related to the frequencies of the words involved. However, our detailed studies of changes in progress on a continental scale find little evidence of the frequency effects that are essential to the exemplar model.

2.1. How are categorical allophones created?

There is little disagreement about the categorical character of allophonic differences like the English contrast of initial aspirated /p/ in *pin* and *pinafore* with the unaspirated /p/ of *spin* and *spinnaker*. Although the degree of initial and final aspiration of stops is variable, no one has as yet suggested lexical, gender or social class differences or frequency effects on the absence of aspiration after /s/. Perhaps future applications of exemplar theory will do so. In the Atlas of North American English, we have systematically studied many cases of vowel allophony, testing for exactly the type of frequency effects that would be predicted by exemplar theory. These cases include the effect of a following nasal on the raising and tensing of short-*a*, Canadian raising of /ay/ before voiceless consonants, and the constraint on the fronting of /uw/ and /ow/ before liquids. In these situations, a single phonetic effect typically dominates all others. In the nasal system of tensing short-*a*, all words with nasal codas are tense, frequently in high front position, and all others are lax in low front-central position. Though there are small phonetic differences within each category, the distribution into two widely separated groups is independent of lexical identity or frequency. Pierrehumbert agrees that such categorical allophony is to be found, and argues that it is created by a sorting process that is originally lexically sensitive. Sound changes in progress offer an opportunity to test this hypothesis.

The Atlas shows that variable fronting of /uw/ occurs in all North American dialects except in two limited areas of the North Central and Eastern New England dialects. The fronting of /ow/ operates strongly in the Mid-Atlantic, Midland and South, but only weakly in the North, Canada or the West. Fig. 3 shows a characteristic example of extreme fronting of /uw/, /ow/ and /aw/ in the Midland city of Columbus, Ohio. All words with /uw/ not before liquids are shifted to high front nonperipheral position, irrespective of frequency.

[11]This is the explicit position taken in Krishnamurti (1998), and many other recent exponents of lexical diffusion.

[12]Although all recent publications on the topic report the process of lexical diffusion (e.g. Krishnamurti, 1998; Ogura, 1987; Phillips 1980, 1984) this is primarily the result of the fact that regular sound change is so widely accepted in historical linguistics that regularity is not a reportable or publishable finding.

[13]This is far from the whole story. Ferguson (1990) points out that Spanish aspiration and deletion of coda /s/ is typically Neogrammarian, while Greek (and Gondi) aspiration and deletion of onset and medial /s/ is typically lexical.

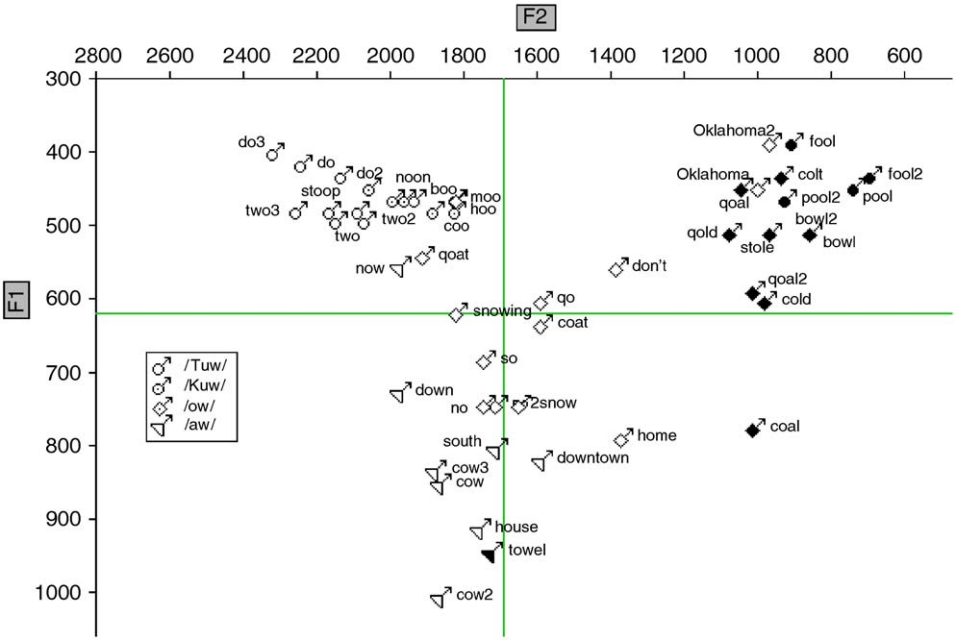

Fig. 3. Back upgliding vowels of Evelyn S. 26 [1999], Columbus, OH TS 746. Solid symbols: vowels before /l/. Tuw = /uw/ after coronals; Kuw = /uw/ after noncoronals.

High frequency *do* behaves like low frequency *dew*. All words before liquids are retained in peripheral back position (vowels before /r/ are not shown here; only those before /l/). The semi-stressed *don't* is in intermediate position. The one lexical exception is *home*, an effect that is repeated in every vowel chart where the word appears. Entering all phonetic features of the onset and the coda into the regression equations for the second formant of /ow/ does not eliminate the backing effect for this one word. It may have been due to the combined effect of onset /h/ and coda /m/, but this seems at first glance an illegitimate way of transforming lexical identity into phonetic terms, and *home* was originally considered a lexical exception. But the behavior of the word *Oklahoma* in Fig. 3 is the key to the situation. *Oklahoma* is equally excepted from fronting, and this cannot be accounted for by any lexical identity of *home* and *Oklahoma*. The *home* effect indeed turns out to be a phonetic one. This can be confirmed by the mean values by searching the ANAE records for this small word class in the entire Southeastern region in which /ow/ is fronted (the Mid-Atlantic, Western Pennsylvania, Midland and Southern dialects).

	N	Mean F2
Vowels before /l/	737	1052
Home	301	1167
Oklahoma	9	1086
All others	1764	1320

A quantitative approach to the sound change as a whole may be illuminating. The major constraints on /uw/ and /ow/ fronting are phonetic factors which hold constant throughout North America.[14] Of the 134,000 vowels measured by ANAE for 439 speakers, 8296 were stressed tokens of /ow/. Table 1 (p. 6) shows the results of a multiple regression analysis of a randomly selected split half of this data set. Eight phonetic

[14]There is a tendency towards fronting /uw/ and /u/ before /l/ in the South, but it never approaches the fronting of other vowels and is now rapidly receding (ANAE, Chapter 12).

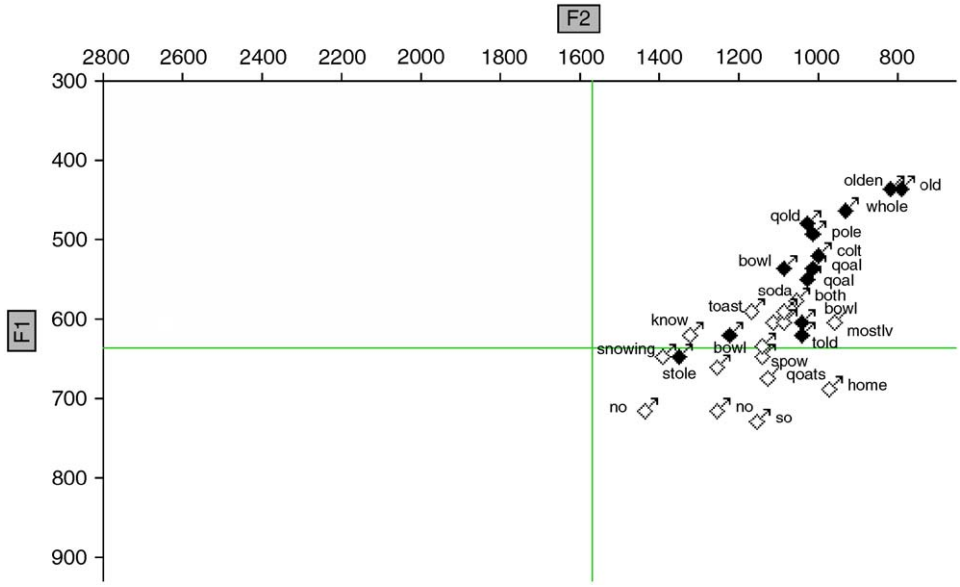

Fig. 4. Distribution of /ow/ for a conservative speaker, Natalie M., 42, Portland Maine, TS 427. Solid symbols: Vowels before /l/.

constraints emerge as robust factors at the $p<.0001$ level, with a lateral coda by far the largest. The social factors of age, sex and city size are small but significant effects. One lexical effect is found: the word *no* is fronted more than other words with an apical nasal onset and no coda, in contrast with its frequent homonym *know*. No significant effect of frequency is found for the fronting of /ow/ or for the fronting of /uw/.[15] The search for lexical effects on changes in progress is largely negative so far. The new and vigorous changes that are operating in North America as a whole, or in particular regions, appear to be regular sound changes in just the sense that the Neogrammarians intended.[16]

The overpowering constraint is the prohibition of fronting before liquids /l/ and /r/. This appears to be a language-specific selection of an abstract category, rather than the automatic product of a universal phonetic apparatus. Back vowels before liquids are fronted in many languages (e.g. French). More to the point, the categorical constraint against fronting of back upgliding vowels before /l/ is not universal even in English: it does not operate for /aw/. Fig. 3 shows that *towel* is fronted along with other tokens of /aw/. This is characteristic of /aw/ before /l/ generally in the entire Southeastern region.

The general conclusion to be drawn from such studies of sound change in progress is that selection for participation in these processes is defined by the type of abstract, discrete and unitary categorization that Pierrrehumbert defines as the standard model. As the change progresses, it is still dominated by phonetic factors but within these constraints, the variation can show small lexical as well as social effects. In other words, social variation takes place within the parameters defined by the discrete structural constraints that are shared by the speech community as a whole.

This raises the difficult question as to how such discrete structural constraints arise. The fronting of /ow/ is a change in progress, as shown by significant age coefficients in most regions. The ANAE records include many conservative speakers showing the earliest stages of this process, where /ow/ forms a continuous distribution. Fig. 4 is the /ow/ pattern of a 45-year-old woman from Portland, Maine. All vowels are back, but vowels before /l/ overlap and form a continuous distribution with others. Within this range we can trace from front to back *snowing, stole, bowl, snow, soda, told, bowl, mostly*. Let us assume that within this continuous range the speakers remember the various exemplars associated with younger speakers of the upper working class in the words most favored by the change. What process can transform this quantitative range into the discrete break

[15]As measured by frequency in the Brown corpus or the British National corpus.

[16]It should be noted that very few of these changes weaken the phonetic output, and must be classed as involving fortition rather than lenition.

of Fig. 3 where the lexical identities and frequencies of vowels before liquids are no longer relevant? If the effect of following liquids were universal, this might be easier to explain, but as we have seen, it is not: it is language and dialect-specific.

The authors of these papers are not unaware of the problems involved here. Johnson's paper concludes with the thought that "abstract phonological patterns may emerge from relations among exemplars that are related to each other by semantic ties." This is a program for the future. But if such massive sound changes as the fronting of /uw/ and /ow/ continue to show the type of regularity exemplified here, it is not clear how the exemplar theory will deal with them, since lexical frequency is such an integral part of the model.

2.2. What does the sociolinguistic monitor store?

Much of our current work is devoted to a study of the nature of the "sociolinguistic monitor" which observes, processes and stores social information. Whether or not this is a distinct component of the linguistic faculty, we find that listeners can track, store and evaluate the frequencies of sociolinguistic variables in a way consistent with the social distributions we track in production (Labov, Ash, Baranowski et al., 2006). It seems likely that this social information is retrieved in the course of the operations that process grammatical and phonetic data to obtain semantic information, but that it is stored in a different form. This becomes evident for sociolinguistic variables in which each use carries discrete social information. In many western European languages, the use of pronouns of power and solidarity (Brown & Gilman, 1960) to categorize a social relation may be registered by the use of subject pronouns, object pronouns, possessive pronouns or verbal inflections. In order to know if someone has claimed a solidary or non-solidary relation, one must extract this general information in the course of syntactic and morphological analysis of the sentence. But as far as I know, or have been able to find out, there are no cases where the social significance depends on what part of speech was involved. *Tu, te, toi, ta* and *ton* are all equivalent in this respect. This suggests that the social information might be stored and interpreted separately from other semantic information as a single abstract judgment, rather than in the form of a remembered word.

More generally, the emphasis on remembered words in this development of exemplar theory seems to me problematic, and carries the field further away from the insights gained in the analysis of linguistic structures over the past century. Johnson rightly says that the average person perceives and talks about language in terms of words. But this hardly means that the non-linguist has a clearer view of language processing than the linguist. On the contrary, ordinary language lacks the vocabulary needed to deal with language structure, and language structure is unobservable without such an abstract vocabulary. *Word* is not the most useful member of this vocabulary for linguistic analysis, as opposed to *morpheme, root,* and *stem*. None of the discussions of exemplar theory presented here discuss the problem of whether we remember and store phonological words, words with clitics attached or inflected words, though there may be work on this problem that I am not familiar with.[17]

There can be no doubt that abstract structures of some complexity remain in memory. Priming experiments and studies of perseverance effects in production show that speakers are sensitive to repeated occurrences of subject/verb agreement or lack of agreement, even when these are far below the level of social awareness (Poplack, 1980, 1981; Scherre & Naro, 1991; Weiner & Labov, 1983). However, the particular issue for sociophonetics is what forms are socially evaluated and what social evaluations are retained in memory.

The sociophonetic papers argue strongly for the importance of social factors in speech perception. HWD warn:

> Whenever the production of a target variable displays social variation, the social characteristics of the participants, as well as the social attributes they attribute to the stimuli are likely to play a role in participants' behavior in perception tasks.

[17]A reviewer of these comments points out that exemplar theory is actually about much more than remembered words, but also deals with generalizations that emerge from exemplar distributions. I have not been able to follow these developments in the detail they deserve, and my observations are based on the approach in these four papers, which consistently refer to words as the basic units of linguistic processing.

The question of greatest interest is how this social information is stored and in what form it is retrieved. The proposal here is that it is stored in the remembered tokens of actual utterances, and extracted from those exemplars. It is true enough that abstract structures rarely receive social evaluation. It is generally true that speakers of the language do not perceive or remark on the structural relations that are the main subject of linguistic analysis.[18] The existence of a phonemic merger is rarely the topic of social comment: rather, attention is directed to the phonetic realization of one member of the other. It might be said that the remembered items are on the surface: that it is the words and sounds of the language that are socially evaluated. But this is only a first approximation. In fact, words or sounds are not socially stigmatized or awarded prestige. The actual interface is not on the surface, but at a more abstract level than this.

If the word were the unit of evaluation, we would find cases where a word *puke* for 'vomit' was stigmatized, but that *pukes, puking* or *puked* was not. We do not find phenomena of this kind. It is appears that it is the stem that is socially evaluated, not the word as it is delivered with its inflectional affixes intact. In other words, social evaluation is performed on a lemmatized lexicon.[19]

In the same way, sounds never receive social evaluation. Speakers of Mid-Atlantic American English will frequently condemn the "harsh/ugly/nasal sound of *bad*." However, it cannot be the sound [iə] that they are referring to, since the identical sound in *idea* is never stigmatized nor does it serve as the subject of social comment. What people note and remember is the use of a particular allophone to instantiate a particular phoneme. What people evaluate is not a sound trace or a word, but something more abstract. It seems that the objects of social evaluation that are remembered and stored undergo a preliminary analysis and the social information is attached to a more abstract object than the remembered exemplars. This abstraction may be retrieved and labeled with a word, because there is no other vocabulary available.

The authors of these papers are not unconscious of the need to relate exemplar processing to abstract structures. We note occasional references to "labels" that are assigned to clouds of exemplars. How these labels are created and how they are divorced from the exemplars that were used to create them is related to the familiar problem of how quantitative relations are transformed to qualitative ones. There is no doubt that exemplar theory has identified a likely mechanism for the transmission of social variation. It remains to be seen how it can be linked to our general understanding of the abstract and discrete representations that characterize linguistic structure and drive linguistic change in progress.

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[18]A striking counter-example is negative concord, a highly evaluated variable that is entirely structural in character.

[19]There are many cases where derivational forms, idiomatic and compounded forms are differentially evaluated, so that it does not seem that the root is the unit of social evaluation. Thus one may have very different social evaluation of *piss, pisser* and *piss off*.

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