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1 Introduction

Over the past 40 years, studies of linguistic variation have produced a great deal of data on the regular social and stylistic stratification of sociolinguistic variables.[1] Fine-grained differences have been observed and replicated in the production of stable sociolinguistic variables like (ING), (DH), or Spanish (S), with significant differences between four or five social levels and four or five stylistic levels (Labov 1966, Trudgill 1974, Cedergren 1973, Weinberg 1974). Figure 1 is a typical product of such studies: the graphic representation of the social and stylistic stratification of (ING) in New York City.

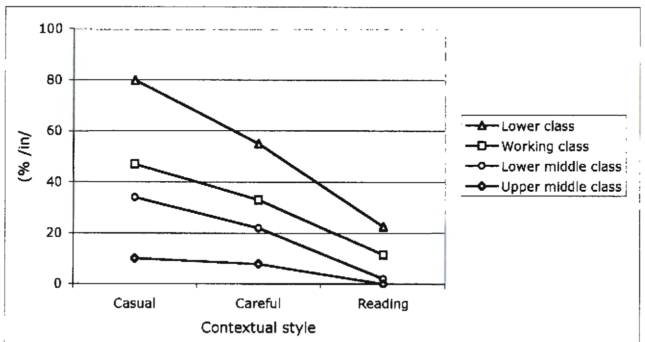

Figure 1: Social and stylistic stratification of (ING) in New York City (Labov 1966)

The vertical axis is the frequency of the non-standard apical variant in the alternation of /in/ and /iŋ/ in unstressed syllables, and the horizontal axis

[1] Support from NSF under Grant BCS-0426061 is gratefully acknowledged. We are particularly indebted to Dan Swingley and Virginia Richards for helpful insights on the interpretation of the mathematical form of our results.

orders contextual style by the relative degree of attention paid to speech.[2] The graph suggests that if the data sets were expanded further, even finer degrees of differentiation could be achieved. The underlying regularity reflects an independent and linear effect of social status and formality, as shown by equation (1), where SEC = socio-economic class and ATS = attention paid to speech.

(1) (ING) = a + b * SEC + c * ATS

A multiple regression analysis of the data using SEC and ATS as independent variables produces the results of Table 1. Here the residual factor for SEC is Lower Class, and for ATS, Reading Style. All factors are significant and account for 83% of the variance. Entering these coefficients into formula (1), we obtain the expected values of Figure 2. Indications of a floor effect in Figure 1 are confirmed by the fact that the expected values project below 0. The observed data differ from the model primarily in that class differences are minimized when the maximum attention is paid to speech. Nevertheless, Figure 2 confirms the expectation of regular and independent effects of style and social class. Since style is an ordinal rather than an interval scale, the even spacing along the horizontal axis is a matter of convention. We can say that each increment in social status is accompanied by an increment in use of the prestige variable and each increment in attention paid to speech is accompanied by a similar increase, with all indications that these relationships are approximately linear.

Variable	Coefficient	s.e. of Coeff	t-ratio	prob
Constant	34	6.8	5.01	0.0024
Upper Middle Class	-47	7.9	-5.86	0.0011
Lower Middle Class	-33	7.9	-4.18	0.0058
Working Class	-22	7.9	-2.77	0.0324
Casual speech	33	6.9	4.91	0.0027
Careful speech	20	6.9	2.97	0.0249

Table 1: Multiple regression analysis of data of Figure 1

[2] It should be clear from the many discussions of the underlying basis of style shifting that this is a way of organizing the style shifting that takes place within the interview context, rather than a theory about the overall organization of style in everyday life (Eckert and Rickford 2001),

This paper is a first report on an ongoing investigation of the manner in which community members perceive this variation in production. The experiments we will report here are designed to determine whether listeners can discriminate and evaluate the frequencies of the variants of Figure 1. More generally, we are concerned with an understanding of how stable sociolinguistic variables are acquired and operate to affect social categorization in everyday life. We posit the presence of a Sociolinguistic Monitor [SLM] that operates on socially marked information consequent to grammatical and phonological processing.[3] Such a monitor would control the effect of frequency of sociolinguistic variants on social judgments, and the development of shared normative values in the speech community.

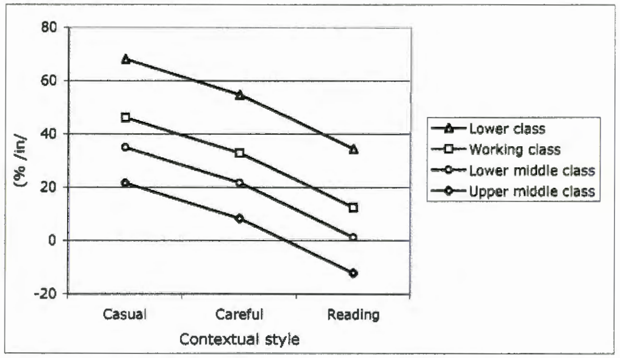

Figure 2: Expected values for (ING) in New York City produced by equation (1) with data supplied by Table 1

It is clear that the recognition of /in/ or /iŋ/ as sociolinguistic variants requires a preliminary phonological analysis of the segments of the relevant unstressed syllable, and then identification of the choice made by the speaker in terms of sociolinguistic norms. There are sociolinguistic variables like the T/V pronouns (Brown and Gilman 1960) where the recognition of only one such choice provides the basis for sociolinguistic interpretation and subsequent action on the part of the listener. But for members of the speech community to detect and categorize the performance of a speaker in terms of the framework presented by Figure 1, it is not sufficient to detect and categorize

[3] The socially marked variants considered here represent choices within a given phonological, morphological, or syntactic structure. Considerable structural analysis is required before such choice points can be identified, variants registered, and evaluation registered and stored.

a single token. To enable the formation of judgments about style- or social-class-appropriate use of (ING), the frequency of successive choices must be tracked and stored while other speech processing continues.[4] The three critical properties of the SLM that we will investigate are:

- *temporal window*: over what span of time do listeners monitor sociolinguistic variation?
- *sensitivity*: what is the just noticeable difference in frequencies that the SLM can detect?
- *linearity*: is the impact of successive instances of the variable constant or does it vary over time within the temporal window?

The temporal window might be quite short, or extend indefinitely across speech turns or encounters. Sensitivity could be limited to a tripartite choice of always/variable/never, or be fine enough to register any differences that are significant in production. Impact across time might be exactly linear, increase or attenuate. Our initial hypotheses are framed in terms of our experimental paradigm, which involves ten successive occurrences of the sociolinguistic variable:

1. The temporal window is wide enough to register the impact of all ten tokens
2. Sensitivity is high enough to distinguish frequency differences as small as 10%
3. Impact is attenuated over time in a non-linear fashion.

The first stages of our research have explored these issues for one linguistic variable, (ING). The regular stylistic and social stratification of /in/ and /iŋ/ shown in Figure 1 for New York City has also been reported in New England (Fischer 1958), Philadelphia (Cofer 1972), Missouri (Mock 1979), Norwich, England (Trudgill 1974), Ulster (Kingsmore 1995), Northern Ireland (Douglas-Cowie 1978), Australia (Peterson 1965), and many cities of Great Britain and the United States in Houston's 1985 study. As a sociolinguistic variable, (ING) is a recognized stereotype ("dropping the g"), and it is overtly and accurately associated with informality.

[4] A growing body of sociophonetic research shows that listeners store and remember information on speaker identity and speech rate even when this information is irrelevant to the main communicative message (Bradow, Nygaard and Pisoni 1999, Hay, Warren and Drager in press). This information is either stored and remembered as a discrete social judgment of the speaker or retrieved from remembered exemplars of lexical items (Pierrehumbert 2002). The SLM might be conceived of as a separate processing and storage module, or as the capacity to do a calculation 'on the fly' at any time by an inspection of remembered tokens. For the moment, our research is neutral on this issue.

2 Experiments

2.1 Experiment 1: Sensitivity to (ING) frequency in Philadelphia

The Newscast Experiment was designed to test listeners' ability to detect and judge the range of frequency of /in/ and /iŋ/ variants from 0 to 100%. The test passage is a news broadcast (2) containing ten progressive *–ing* suffixes:

(2) The Newscast passage

> President Bush announced tonight that he was *putting* all available White House resources into support for the new tax cut bill.
>
> Democratic leaders of the House and Senate are *preparing* compromise legislation.
>
> Republican spokespersons predicted that record numbers of *working*-class Americans would be *receiving* tax refund checks before the end of the year.
>
> Senator Edward Kennedy's staff announced that the tax cuts are *creating* a new elite who are excused from *paying* their fair share of the cost of government.
>
> At the Office of Management of the Budget, officials are *trying* to estimate the size of the deficit that will be produced by the new legislation.
>
> Federal Reserve Board chairman Alan Greenspan stated that he was not *confirming* that tax cuts would lead to a change in prime interest rates, nor was he *denying* it.
>
> The Washington Post is *publishing* today a list of all members of Congress who will receive tax refunds greater than $1,000 as a result of the proposed tax cuts.

The stimuli were recorded in a sound-attenuating booth. A speaker of a conservative Northern dialect (SA) read the passage first with consistent /iŋ/ forms for each italicized progressive and then with consistent /in/. The speaker was recorded multiple times until all of the text was recorded in performance approximating broadcast style. The stimuli were then constructed by editing the speech signal using Praat (Boersma and Weenink 2004, v. 4.2.07). The best productions of the passage were selected, splicing as needed to produce one best version of the passage. An alternative version for each sentence or phrase containing one token of the variable was produced by replacing the token with the best production of its alternative variant. The phrases and sentences were then concatenated in the order needed to produce the desired sequence of variants of (ING). Thus the stimulus passages are exactly the same except for the variable of interest, with frequencies of /iŋ/ ranging from zero to 100%.

Experiment 1 was administered to a group of 23 University of Pennsylvania undergraduates. Answer sheets in the form of (3) were given to students and the instructions shown at the top were read aloud.

(3) A woman has been studying to be a newscaster and has applied for a job with a local radio station. Here are five versions of a trial newscast that she read to submit with her job application. Please rate each one on the following scale by putting a check in one box.

Perfectly professional Try some other line of work

1	2	3	4	5	6	7
/_____	/_____	/_____	/_____	/_____	/_____	/_____ /

The test stimuli were played through a Nagra III loudspeaker which has been found to project sound with maximum clarity to rooms of this size. Results of the first group experiment are shown in Figure 3, with frequencies of /in/ at 0, 30, 50, 70 and 100%. The horizontal axis is the percent of /in/ and the vertical axis the mean rating on the scale defined in (3), with better performance at the bottom and worse performance at the top. This first experiment included a test of the effect of blocks of the same variant as opposed to alternating sequences; the two 50% passages had blocks of five /iŋ/ first (50a) or five /in/ first (50b).

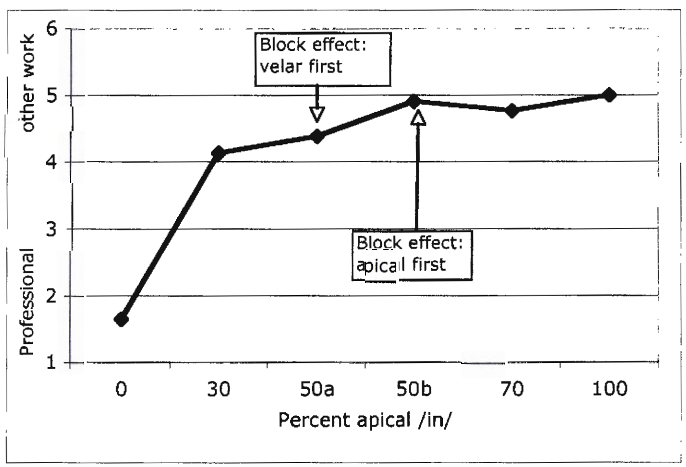

Figure 3: Mean ratings for Experiment 1. Site: Philadelphia. Speaker: SA, N=23.

The overall pattern of Figure 3 indicates that listeners are sensitive to the sociolinguistic norms governing (ING). The curve rises steadily with increasing percentage of /in/, indicating an increasingly critical reaction to higher frequencies of the apical variant. This indicates that the width of the temporal window is not less than the time span of the experiment. To judge sensitivity along this scale, we must consider the average of the 50% block trials.

/in/ frequencies	mean ratings of /in/ frequencies	p(t-test)
0/30%	1.65/ 4.13	<.001
30/50%	4.13/4.70	.02
50/70	4.70/4.77	.32
70/100	4.77/5,00	.069

It seems that the subject group can discriminate differences in frequency as small as 20%, but they do so less accurately as /in/ frequencies rise.

The differentiation of the two 50% block trials is small but significant (p = .033, 1-tailed t-test). Since the 50% /in/-first trial is not significantly different from 100% /in/, this raises the possibility that the subjects do stop monitoring after hearing five /in/ tokens in a row. On the other hand, the 50% /iŋ/-first trial is very far from the 100% /iŋ/ trial (that is, 0% /in/), which indicates that subjects did not stop monitoring after hearing five /iŋ/ tokens in a row. We will return to this asymmetry and the width of the temporal window after a more detailed analysis of the relation of evaluation to frequency.

An inspection of Figure 3 suggests that the distribution by frequency follows a logarithmic progression. Figure 4 superimposes a logarithmic trend line on Figure 3, with the two 50% ratings averaged together. The slope is 1.44, and the fit is quite close, with an r^2 of .97, indicating that 97% of the variance from the overall mean is explained by the logarithmic function, with only 3% noise. For the trial with 0% /in/ forms, the rating of 1.7 is close to "Perfectly professional." With 30% /in/, the mean rating jumps to 4.1. However, this fit is heavily weighted by one value, the mean rating with 0% /in/. Figure 5 shows that if we exclude this point, the other four are a good fit to a linear relation, with $r^2 = .89$.

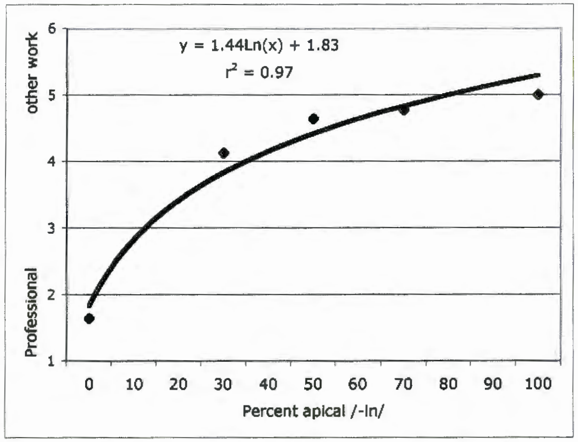

Figure 4: Fit to logarithmic progression of data of Figure 3

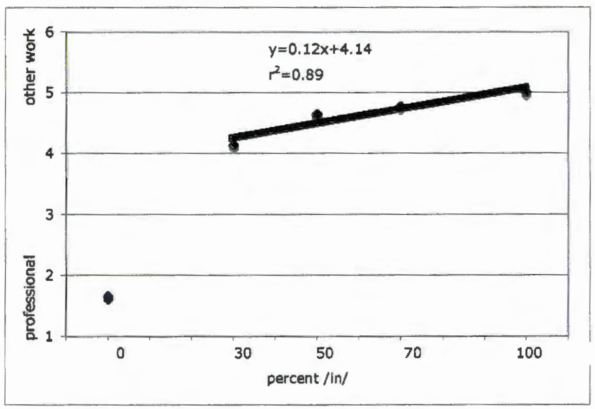

Figure 5: Approximation of Figure 4 to a linear relation with the zero point excluded

2.2 Experiment 2: Defining the logarithmic function

A second experiment was designed to test the logarithmic relation more closely by inserting two more points at the lower end of the /in/ scale, 10% and 20%, and by including only one passage with 50% /in/. The additional passages were constructed using the methods discussed above. After these modifications, Experiment 2 included seven trials, ranging from 0% /in/ to 100% /in/. This test was administered to 36 University of Pennsylvania undergraduates in the same way as Experiment 1, with the results shown in Figure 6. The fit to the logarithmic function is excellent, with an r^2 of .96 and a slope of 1.52, similar to the 1.44 of Figure 4.

The asymmetry of the function is striking. If we should reverse the dependent variable and plot the percentages of /iŋ/, the impact of a 10% use of /iŋ/ will be very small, and hardly different from none at all. But in Figure 6, the 10%

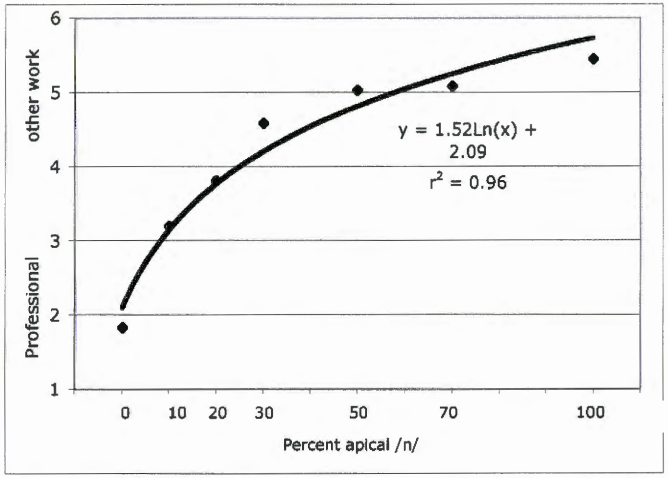

Figure 6: Mean ratings of Newcast Experiment 2 with logarithmic progression. Site: Philadelphia. N = 36

of /in/ has the maximum impact. It is evident that in the evaluation of (ING) in this formal speech context, /in/ is the marked variant and /iŋ/ is the expected, or unmarked variant.

2.2.1 Gender differences

The results of Experiment 2 were also analyzed for gender differences. The 36 subjects included 25 females and 11 males. Figure 7 shows that both subgroups follow the logarithmic curve closely, with r^2 of .94 and .99. The function calculated for males has a lower intercept than the function for females, and is generally higher. This fits with other indications that women and are more sensitive than men to the use of nonstandard variants in formal contexts (Labov 1966, Trudgill 1974).

T-tests show that the differences between the mean ratings of male and female values for any level of /in/ are small, and lack significance. But since they are all in the same direction, we can follow Fischer (1925) to obtain the overall significance of the gender difference by adding the logs of each p-value. As shown in Table 2, twice the absolute value of this sum is equal to χ^2 for the overall relationship with n-1 degrees of freedom. In this case χ^2 is 25 with 6 degrees of freedom, registering an overall probability of these differences being due to chance of .0003.

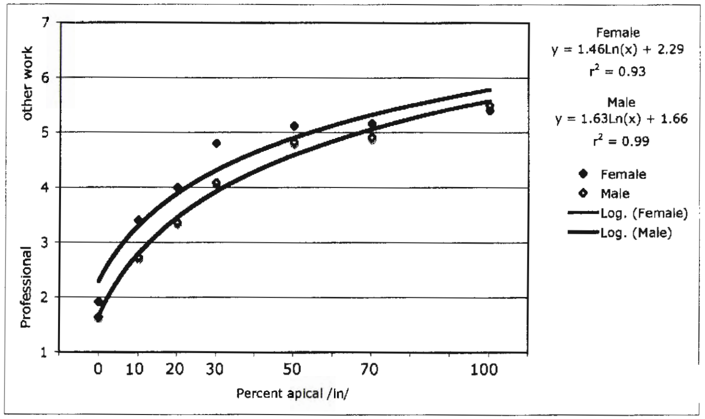

Figure 7: Gender differences in Newscast Experiment 2

1	2	3	4	5
Percent /in/	Female	Male	P (t-test)	ln(P)
0	1.92	1.64	0.209	-1.567
10	3.40	2.73	0.031	-3.462
20	4.00	3.36	0.113	-2.177
30	4.80	4.09	0.104	-2.261
50	5.12	4.82	0.257	-1.358
70	5.16	4.91	0.295	-1.220
100	5.44	5.45	0.486	-0.721
SUM				-12.766
χ^2=2*|SUM|				25.532
P, 6 d.f.				0.0003

Table 2: Cumulative significance of male/female differences in Experiment 2

2.3 Experiment 3: Testing individual subjects

In Experiments 1 and 2 administered to groups, subjects had available a choice of seven ratings and could not register distinctions smaller than these. Newscast Experiment 3 was designed to enlarge that range for individual subjects with a technique of magnitude estimation (Bard et al. 1996) which allows subjects to determine their own scale of similarities and differences. The speaker, SA, was the same as in Experiments 1 and 2. The instructions for subjects were adapted for computer administration as shown in Figure 8, the format for Trial 1 of Newscast Experiment 3. Subjects initiate each of the newscast trials by clicking on "Play." As they hear the person reading the sentences with varying frequencies of /in/ and /iŋ/, they move the slider on a continuous scale to the right or left. As the slider moves to the right towards "Perfectly professional." the number underneath it increases steadily upward from 500 to a limit of 1000. As the slider moves to the left, the value descends steadily to a limiting value of 0. A later report will deal with the coordination of subjects' slider movements with the location in time of the (ING) variants; here we will be concerned only with the final slider position and how the pattern compares to the group experiments with seven discrete choices.

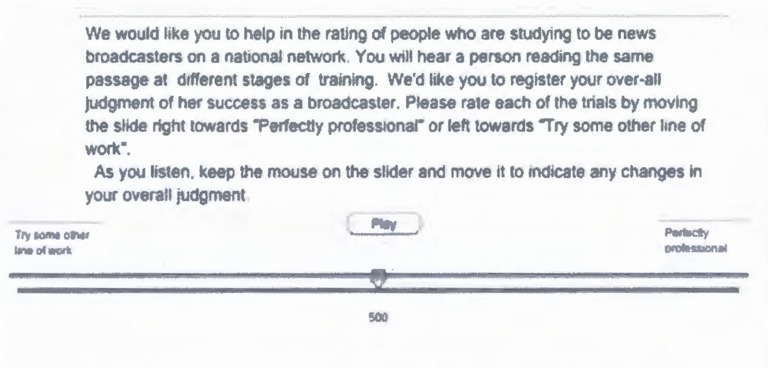

Figure 8: Design of individual Newscast Experiment 3 (Trial 1)

Figure 9 displays the overall results for the 56 individual subjects of Experiment 3, who were recruited by a general advertisement for a linguistic experiment and paid $20 per hour. Four different orders of the stimuli were rotated with each individual subject; in all orders, the 50% trial was placed first as a point of reference. The horizontal axis again shows the percent /in/, and the vertical axis shows the mean values for the final position of the slider. The fit with the logarithm relation is as close as in Experiment 2, with $r^2 = .94$. The most aberrant point, at 50% /in/, may be connected with its positioning as the first trial in the series.

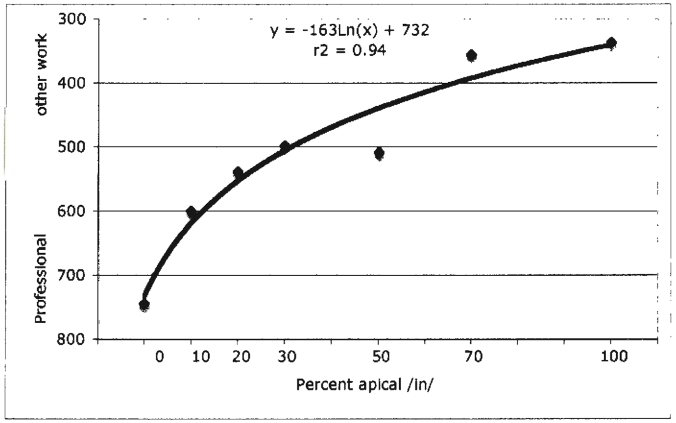

Figure 9: Mean ratings of individual subjects for Newscast Experiment 3. Speaker: SA. N=56

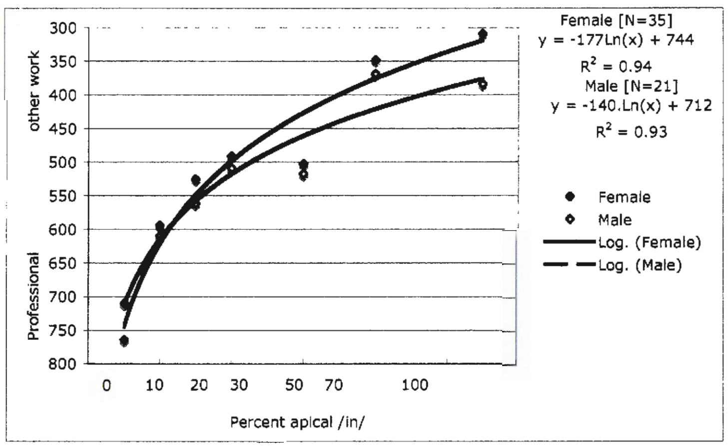

Figure 10: Mean ratings of individual subjects in Newscast Experiment 3 by gender.

Figure 10 shows that in Experiment 3, both genders replicate the logarithmic curve, with the same high r^2 values. Both men and women show the relatively higher rating for the 50% trial. These gender differences, however, are not quite the same as those in Experiment 2. Women again penalize the high frequencies of /in/ more than men do, but in contrast they award a higher rating for the consistent use of /iŋ/. As with the gender differences of Experiment 2, the series of non-significant differences add up to a significant one (excluding the value for 0% /in/). The overall pattern is that of a steeper slope of evaluation for women compared to men (-177 vs. -140), which is characteristic of women's behavior with the vowel variables of New York City (Labov 1966, Ch. 8), (ING) in Norwich (Trudgill 1974), negative concord in Detroit (Wolfram 1969), and many other cases (Labov 1990).

2.4 Replicating Experiment 2 in the South: Evaluation of (ING) in South Carolina

The (ING) variable is quite general in the English-speaking world but operates at different levels in different regions. It is well suited for regional comparisons of the functioning and sensitivity of the SLM. The regional composition of the subject pool for Experiment 2 carried out at Penn is shown in the first two columns of Table 3. The wide geographic range and the large number of students with mixed background is characteristic of this university. At the same time, there are relatively few subjects from New England or the South. To test the generality of the logarithmic relationship found among Philadelphia subjects, we turned to our two other sites: Columbia, South Carolina and Durham, New Hampshire.

It is well established that the level of /in/ use in the Southern U.S. is higher than in the North (Houston 1985). The apical variant is freely used by educated Southerners even in formal situations. One may therefore ask if the same evaluative norms operate in the South as in the North, and if there are differences, whether the logarithmic relationship will be modified in Southern contexts. Weldon replicated Newscast Experiment 2 with 55 students at the University of South Carolina in Columbia, using the same stimuli and format. The third and fourth columns of Table 3 show the regional distribution of the USC subjects for Experiment 2-USC. It is immediately apparent that the regional concentration is much greater. Three-quarters of the group are from the South, and three-quarters of these are from South Carolina.

	U. of Penn		USC		UNH	
Mid-Atlantic		14		2		0
Philadelphia and suburbs	8					
NYC and suburbs	4					
Other Mid-Atlantic	2					
New England		1				43
New Hampshire					25	
Massachusetts					9	
Oher New England					9	
North		2				3
Midland		1		1		
South		6		41		
Columbia			8			
Charleston			2			
Other South Carolina			24			
Other South			7			
West		3		2		
Canada		1				1
Mixed		8		9		4
Total		36		55		51

Table 3: Regional distribution of subjects for Experiment 2

Figure 11 shows that the USC judges exhibited a logarithmic relationship with an r^2 of .96, the same correlation as in Philadelphia. The evaluation of the frequency range of (ING) is therefore governed by the same factors that operate among the Penn subjects. There are however two differences between the two regions. When we superimpose the ratings of USC subjects on the results for Philadelphia in Figure 12, it becomes apparent that there are differences in the slopes of the curves. The Columbia subjects exhibit a lower slope than Philadelphia subjects, indicating less critical evaluation of the /in/ variant. This difference cannot be due to a gender effect, since the proportion of male judges to females is exactly the same in Philadelphia and Columbia (31%). The major difference is that greater uses of /in/ are downgraded less in Columbia, indicating that the pressure to use /iŋ/ in formal settings is less than among Northern subjects. This matches observations of the relatively high use of /in/ in formal contexts by Southern speakers mentioned above.

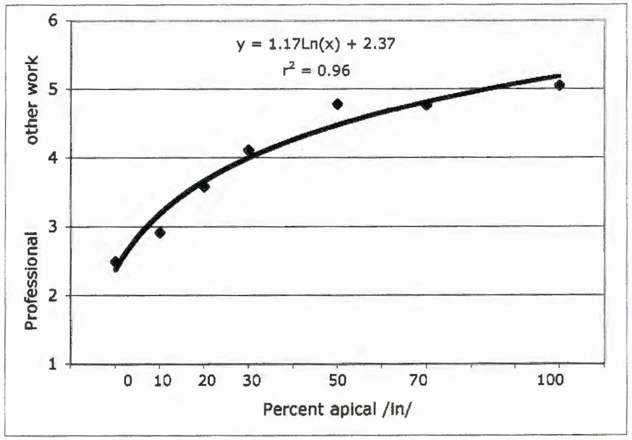

Figure 11: Mean ratings for replication of Newscast Experiment 2 at USC Speaker: SA. N=56

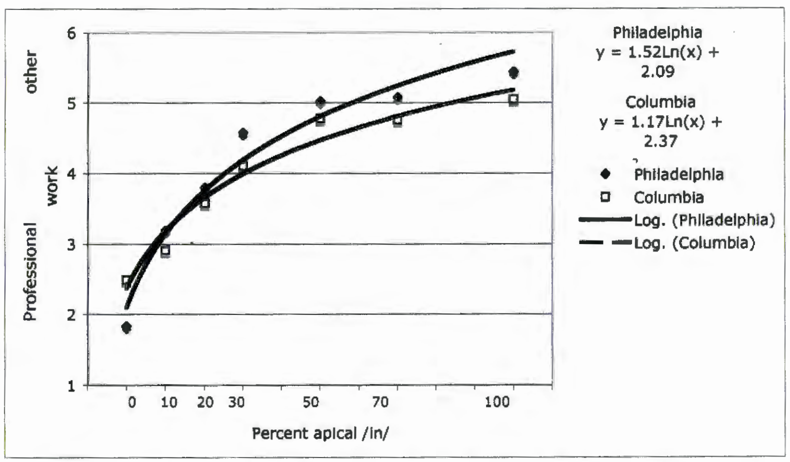

Figure 12: Comparison of Experiment 2 results in Philadelphia and Columbia

The Columbia subjects also differ from the Philadelphia subjects in regard to gender. No differences appear in the reactions of male and female judges in the Columbia experiment.

2.5 Experiment 4: Evaluation of a Southern speaker

Differences in the evaluation of (ING) is only one of many differences between Northern and Southern speech patterns (Kurath and McDavid 1961, Labov, Ash and Boberg 2006). We now raise the question as to how the evaluation of (ING) interacts with these regional differences. All of the results presented so far for Experiment 2 are evaluations of the performance of SA, a conservative speaker from Chicago.[5] To explore further the general mechanism that produces the logarithmic progressions of Experiments 1-3, Experiment 4 embedded the alternation of /in/ and /iŋ/ in a radically different context, speech embodying the characteristic regional features of the South. For this purpose, Weldon recorded JB, a local white educated speaker raised in the city of Columbia. As with the preparation of the stimuli for Experiment 2, JB was instructed to read the newscast text in his native speech pattern, but with consistent /iŋ/ for the progressive participles in one reading, and consistent /in/ in a second reading. The newscast trials were then prepared by splicing in JB's /in/ and /iŋ/ tokens in the stipulated proportions into a carrier signal drawn roughly equally from the productions with consistent /in/ and consistent /iŋ/.

The most marked dialect features by which JB's speech differed from that of SA are as follows:

a. Monophthongization of /ay/ before voiced segments (variable) as in *compromise, trying, denying, prime, size.*
b. Moderate activation of the Southern Shift (Labov, Ash and Boberg 2006) in centralized and lowered nucleus of /ey/ in *paying, legislation, creating,* etc. and fronted and raised /e/ in *end, Federal.*
c. Strongly fronted nucleus of /aw/ in *House, thousand, announce,* and /uw/ in *new, produced,* as compared to back of center nuclei for all /Vw/ vowels for SA.
d. Fronted /ʌ/ in *Budget, cut,* etc., as opposed to back forms for SA.

[5] We have no reason to believe that the Chicago articulations of the (ING) variants differ from those produced by speakers in other regions of the U.S.

quency of (ING) spoken by JB. Figure 13 displays a remarkable coincidence of the results of Experiment 2-USC and Experiment 4 in Columbia. The figure superimposes the evaluations of the (ING) trials performed by JB (Experiment 4) and those performed by the Northern speaker SA (Experiment 2-USC). Both results once again show a close fit to the logarithmic progressions with r^2 of .96 and .98. Both show the characteristic shallow slopes first observed in Experiment 3S, with coefficients not far from 1. The underlying pattern of response to shifting levels of (ING) is independent of the other sociolinguistic characteristics of the speakers. Columbia judges differed from the Philadelphia judges in their evaluation of (ING) in a manner independent of the regional dialect features that differentiate the two speakers. Further, it is evident that the experiments succeeded in isolating the effects of the variable (ING) in the Sociolinguistic Monitor.

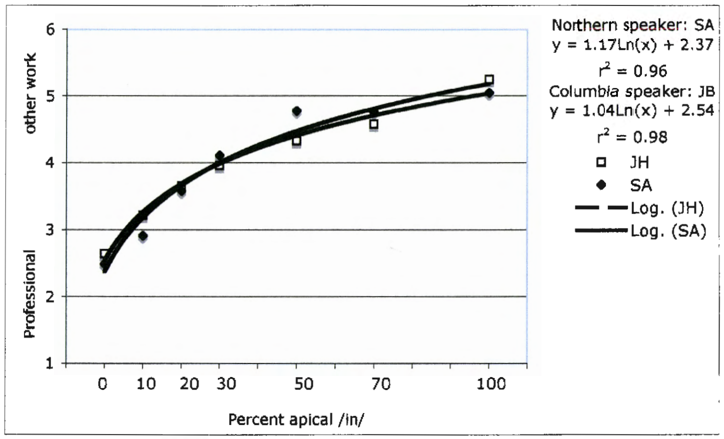

Figure 13: Mean Columbia ratings of Columbia speaker JB in Experiment 4 compared to mean Columbia ratings of Northern speaker SA in Experiment 2-SC.

2.6 Replication of Experiment 2 in New Hampshire

The third regional site for the current research is the University of New Hampshire at Durham. Nagy replicated Experiment 2 at the University of New Hampshire to obtain UNH students' evaluation of variable frequencies of the use of /in/ by SA, the same speaker as in Experiments 1 and 2 in Philadelphia. The results shown in Figure 14 were a marked deviation from the results of previous experiments. It is immediately obvious that the responses did not follow the logarithmic progression found in other areas. The mean ratings of 70% and 100% /in/ are much lower than would be expected—that is, closer to the "Perfectly professional" rating than in Philadelphia or Columbia.

Before we came to the conclusion that New Hampshire subjects were exceptional in this respect, Nagy replicated Experiment 2 under the same conditions with subjects drawn from two undergraduate classes [N=42]. The result for this second replication, shown in Figure 15, returned us to the expected logarithmic progression, with an r^2 of .91. At the same time, we recognize that the New Hampshire subjects exhibit a shallower slope of differentiation (1.07), similar to the slopes found at Columbia (1.17 and 1.04). Unlike the USC students, the UNH students replicated the characteristic difference between males and females in Figure 16, with females showing a steeper slope of social marking of /in/, 1.18 for women as against .81 for males.

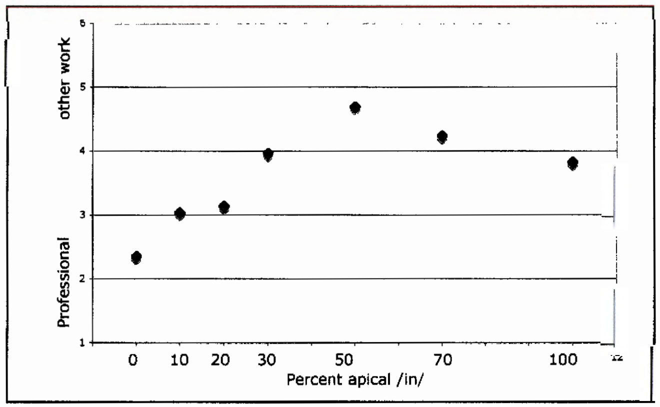

Figure 14: Mean ratings of replication of Experiment 2 with University of New Hampshire students. Speaker: SA. N = 51. Feb 17, 2005

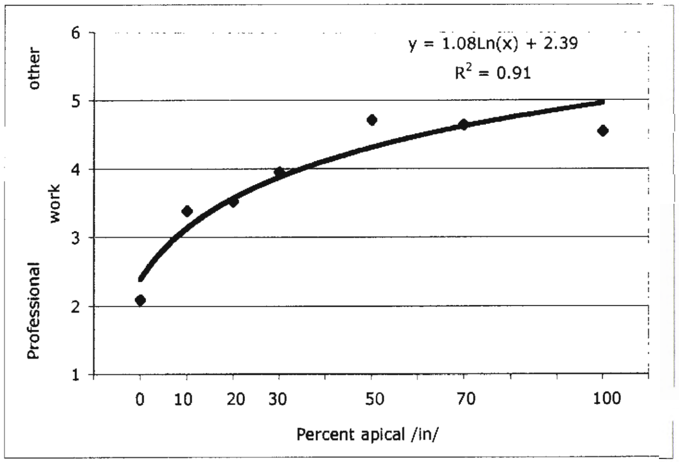

Figure 15: Second replication of Experiment 2 at University of New Hampshire. Speaker: SA. N=42. Oct 13, 2005

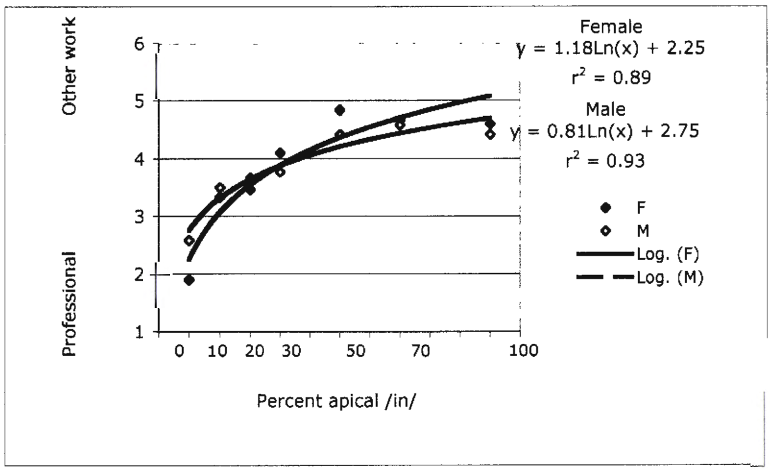

Figure 16: Mean ratings by gender of second replication of Experiment 2 at University of New Hampshire. Female N=30, Male N=12

Both replications of Experiment 2 in New Hampshire indicate that the New Englanders, like the Southerners, are more moderate than the Philadelphia subjects in their use of the 7-point scale to penalize speakers for their use of /in/ in the broadcast trials. The slopes of the logarithmic functions are in the neighborhood of 1.0 and do not approach the 1.5 value characteristic of the Philadelphia judges. We observe in the second replication the same tendency as in the first to flatten the curve at the upper end, or even give better ratings to the highest percentages of /in/. This suggests the possibility of a competing norm for the evaluation of the consistent use of informal /in/ in formal speech.

3 Understanding the logarithmic progression

The logarithmic function found in Figures 4, 6, 7, 9, 10, 11, 12, 13, 15, and 16 cannot be derived from any of the data on speech production of (ING) cited in the references. The unity of these results must depend upon some fundamental property of speech perception, perhaps specific to the Sociolinguistic Monitor, perhaps based on more general properties of perception. While the results of Experiments 2-4 confirm our original hypotheses of a wide temporal window and attenuated impact of the SLM over time, we were not able to predict an attenuation progression as specific as the logarithmic relation. One direction of explanation is suggested by the fact that the logarithm is the integral of 1/x, as in (3), suggesting that the function 1/x plays a role in generating this relationship.

(3)

$$\ln(x) = \int_1^n \frac{dx}{x}$$

Inspection of all the figures provided so far shows that the first occurrence of /in/ in a series has the greatest effect upon the evaluation of the speaker's performance, and in general that each successive occurrence has a proportionately lower effect. If we acknowledge that /in/ is a deviation from expected performance in the newscast trials, it follows that the negative rating increases for each deviation by the proportionate increase in the sum of deviations. Given one deviation, the second represents a 100% increase in the sum, the third a 50% increase, the fourth, a 33% increase, and so on. In other words, a given deviation increases the effect by 1 over the current sum of deviations.

If we are asked to predict the effect of any one occurrence of an apical variant in the Newscast experiment, we begin with the hypothesis that the effect of the i^{th} deviation on the perception of the distance from the norm is a function of the proportional increase in the total number of deviations, so that ΔE, the change in the overall effect is given in (4).

(4)

$$\Delta E = \frac{b}{i-1}$$

The inverse of *i-1* is multiplied by b, a factor that is equivalent to the slope of the logarithmic or linear curve. As we have seen, the parameter *b*, an impact coefficient, can vary from region to region without any change in the fundamental relationship.

If the impact coefficient *b* is 1, the 4^{th} deviation adds 1/3 to the total effect, the 5^{th} deviation 1/4, and so on. If we ask how we can predict the rating given to any one trial in the (ING) experiment, we sum the effects of all the deviations in the manner shown in (5), beginning with another coefficient *a*. This is the rating given to a trial with no deviations—the best effort.

(5)

$$E = a + \frac{b}{1} + \frac{b}{2} + \frac{b}{3} \ldots = a + b * \left(1 + \frac{1}{2} + \frac{1}{3} \ldots\right)$$

or

(6)

$$E = a + b * S$$

(6) abbreviates the proportional increase series as *S*, which equals 1 + 1/2 + 1/3 .. What then is the relationship between the logarithmic function and the series S? The logarithmic progression is a close approximation to the sum of that series. S does not converge, but increases to infinity. The sum for a given number of terms is approximated by ln(n) + g, where g = .5772156649. . . (Euler's constant).

Figure 17 shows how the logarithmic function modified by Euler's constant merges with the cumulative sum *E*. The *E* series fits the logarithmic function with an r^2 of .9975. The logarithmic calculation of course fits itself perfectly There is a gap at the beginning but after 20 terms, there is no discernible difference. Table 4 generates the results of Experiment 2 in Philadelphia by the E function with the initial constant *a* set at 2.00 (that is, the second box on the seven-point scale) and the impact coefficient *b* set at 1.25. χ^2 of the difference between the predicted series and the observed results is very small, indicating no significant difference between the expected and the observed data points.

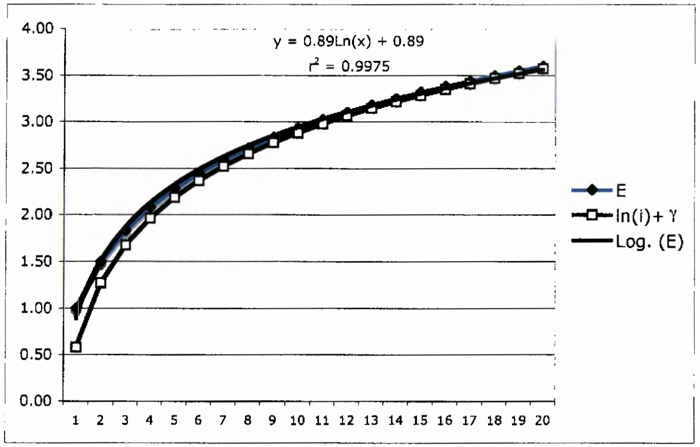

Figure 17: Comparison of logarithmic function modified by Euler's constant g with the proportional error function E. g= .5772156649..

percent /in/	E	Experiment 2
00	2.00	1.83
10	3.25	3.19
20	3.88	3.81
30	4.29	4.58
40	4.60	
50	4.85	5.03
60	5.06	
70	5.24	5.08
80	5.40	
90	5.54	
100	5.66	5.44

Table 4: Generation of the results of Experiment by the E function with initial contant = 2 and impact coefficient = 2.00, Chi-sq = .056, n.s.

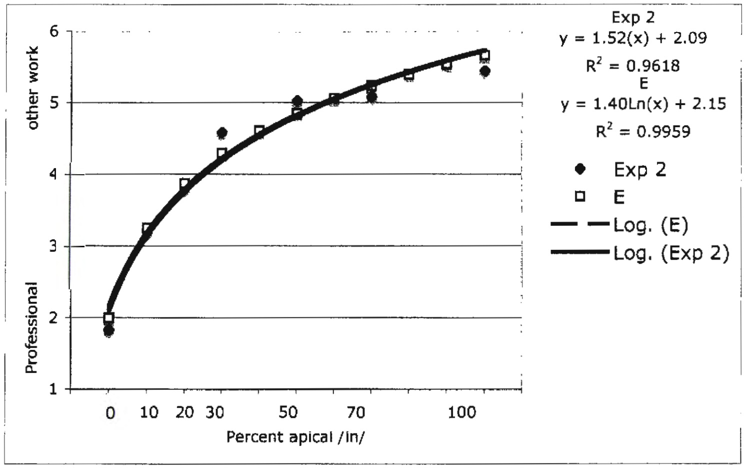

Figure 18: Comparison of the E function with a = 2.00 and b= 1.25 with the results of Experiment 2

Figure 18 plots the two series of Table 4. The two curves are indistinguishable. The logarithmic fit obtained for the experimental results is practically identical with the proportional series calculations of the *E* function.

4 Findings on the Sociolinguistic Monitor

The results of the experiments reported here can be summed up under four characterizations of the SLM:

- Within the limited range of our experiments, the temporal window of the SLM is reasonably wide: it operates continuously across the time frame of the experiment.
- Our subjects show a striking consistency in their evaluation of sociolinguistic variables, clearly sensitive to differences in frequency as small as 10%. However, the very nature of the logarithmic progression undercuts the value of such an approach to sensitivity, since it is now obvious that speakers will have strong reactions to small percentage differences at the low end of the /in/ scale, and slight reactions to differences at the high end. To the extent that the logarithmic relation governs subjective reactions, we can not expect to obtain significant differences at increasingly high percentages of the marked variant.

- The attenuation of responses to the marked variant with increasing exposure in our initial hypotheses is clearly confirmed, but in a much more specific form than expected. The response of the SLM is not linear, but proportional to the increase in the number of marked forms observed.

We have also examined the sensitivity of the monitor to internal constraints on the variable, which we will present in reports to come. In our continuing research, we are expanding the range of variables at the three sites, examining responses to variation in postvocalic /r/ and the monophthongization of /ay/, and comparing responses of subjects of varying ethnicity, age, and education. Experiments with individual subjects will allow us to specify the nature and timing of their response to individual deviations over time. The preliminary results presented here should provide a framework for the further study of the perception of linguistic variation and the operation of the Sociolinguistic Monitor.

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